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~~ALTGELD HALL STACKS~~

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THE

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Communications intended for insertion in the current week's issue should reach us not later than Tuesday Evening.

We cannot undertake to return rejected manuscripts or drawings unless accompanied by a stamped and directed envelope.

Contributors are requested to write on one side only of the paper. Sketches should be sent on separate sheets.

TO ADVERTISERS.

Advertisements intended for insertion in the current issue should reach us on Wednesday morning at the latest.

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NOTICE TO NEWSAGENTS AND SUBSCRIBERS.

Numerous complaints having been made to us by Subscribers of the difficulty they experience in obtaining copies of the *Practical Engineer* in certain districts, we have to state that the Journal can be obtained by any Newsagent through the ordinary Trade channels, and no difficulty should therefore exist in obtaining copies by order of any Newsagent.

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NOTICE.

BACK NUMBERS.—*As we have received several letters from correspondents who have found a difficulty in obtaining* BACK NUMBERS *of the* PRACTICAL ENGINEER, *we have to state that all the back numbers are still in print, and can be obtained from our office on receipt of stamps to cover cost and postage.* CASES *for* BINDING *the* PRACTICAL ENGINEER *can be obtained from the publishers, price 2s.,* POST FREE. VOLUME I., *bound in cloth, containing the numbers from March to December, 1887, can also be had, price 6s. 6d.,* CARRIAGE FREE.

SCIENCE IN 1887.

The year has produced nothing startling in the way of scientific discovery, but it has been a year of steady progress, and a very large amount of good work has been done in all branches of science. We must not judge of the science of the year by the columns of the newspapers, but by the proceedings of the Royal, Chemical, Physical, Linnæan, Geological, and other societies, which now make almost a library year by year.

No new element has been discovered during the year, but the properties of the latest of these, germanium, have been fully investigated, and there is now no doubt but that it is Mendelejeff's Ekasilicon, filling the gap in the periodic table between silicon and tin, and its properties agree very closely with those predicted for Ekasilicon.

The element fluorine, which has for so long resisted all attempts to isolate it, has at last been obtained (by Moissau) by the electrolysis of pure anhydrous hydrofluoric acid, to which hydrogen potassium fluoride had been added to enable it to conduct the current. The element is a colourless gas, and its properties show that it is properly placed at the head of the kalogen series. Its chemical activity is very great, and its affinity for hydrogen is so intense that the gases combine with explosion even in the dark. Much good work has been done during the year in the more accurate determination of constants. Several new atomic weight determinations have been made. Thorpe and Young have determined the atomic weight of silicon, and obtained 28·323 as the number; Thorpe and Laurie have also determined the atomic weight of gold, and arrived at 196·64 as the value. Ramsey and Reynolds have determined the atomic weight of zinc. The experiments in this case were made by measuring the hydrogen given off by the solution of a given weight of pure zinc in acid, so that the comparison being made directly with hydrogen will not need revision when more accurate determinations are made of other elements. The apparatus used for the collection of the gas was very ingenious. The pure zinc used was obtained by electro-decomposition. Among the most important works published during the year must certainly be mentioned Crookes' magnificent researches on radiant matter spectroscopy. These may be taken by the student as models of what a research should be—careful, accurate, and painstaking, following out of a line of study step by step, till it leads to important results. The question of the compound nature of the elements has been much discussed during the year, the discussion having been started by a lecture delivered by Crookes before the Royal Institution. It seems probable that some, at any rate, of the so-called elements may in the future be resolved into simpler forms, but at present, though evidence points in that direction, it is not definite enough to enable us to speak with certainty. Among other important subjects discussed during the year is that of solution, but though many experiments have been made, nothing very definite has been added to our knowledge of the subject.

A work of great importance both theoretically and practically has been undertaken by Mr. Turner, in the investigation of the effects of various impurities on iron and steel; at present the effects of silicon have been studied, and most valuable results have been obtained.

In practical metallurgy there is but little to chronicle; several new processes have been suggested, but it is too soon to say if they will be of any practical value. The production of aluminium has occupied much attention. The Cowles' process introduced a few years ago has been improved, and is in operation, but has not yet materially reduced the price of the metal. Castner has introduced a process for the manufacture of sodium, which it is claimed will much cheapen that metal, and therefore allow of the production of aluminium at a much lower rate than at present by the old process.

In physics there has been much good work, but nothing of very great importance has been done. Electric lighting still continues to increase at a very rapid rate; among other things it has been applied to lighting railway carriages. On the portion of the North British Railway running underground through Glasgow, it has been applied with great success. Town lighting by electricity is gradually coming into favour, and Taunton and Bradford will ere long be lighted by this means. Many attempts have been made to apply electricity to locomotion; one or two electric tramways have worked satisfactorily during the year, and successful experiments have been made with electric engines on ordinary tram lines. The success of electric lighting has, of course, caused great improvement in gas lighting; the important event of the year in the science of gas lighting is the introduction of the Welsbach incandescent burner, which, though invented a year or two ago, has only been brought before the public during last year. This light depends on the fact that when the oxides of some of the rare metals, for example zirconium, are heated, they emit a very bright light. The source of heat is a Bunsen burner, and over this is suspended a cowl of the oxide, which becomes very hot, and emits a bright light.

In biology there has been nothing done during the year of sufficient importance to interest our readers; and in agriculture the only important step has been the use of Thomas-Gilchrist (basic Bessemer) slag as a manure.

PATENTS IN 1887.

The number of applications for patents in 1887 reached the enormous total of 18,029, a number higher than has been attained in any previous year. The increase over last year is 853, and 1,928 over the year 1885. Previous to the operation of the New Patent Act, which came into force in 1884, the number of applications was about 6,000, so that the immediate effect of the new law was to treble the number of patents. The great reduction of fees payable on a patent was, of course, the cause of this great increase, but how long it will continue is problematical. Next year will be a crucial time with patentees, for as it is well known, the first renewal fee does not become due until the end of the fourth year, but then it is a pretty heavy one. The first patents granted under the new act have just completed their fourth year, and the renewal fees will be due, and it is very likely that an enormous proportion of them will lapse. Under the previous law with the same renewal fee only 30 per cent. of completed patents were continued into the second stage, and we should not be far wrong in surmising that not one fifth of the 1884 patents will be in force next year at this time. The lowness of the preliminary fee has naturally induced many a one to patent an invention scarcely worth the name, and for which a year's protection may suffice, and in fact nearly one half of the inventions that have been provisionally protected are not thought, by the inventors, at the end of a year, to be worth £3. This is a curious fact, and ought to be a warning to those who feel ready to rush to the Patent Office whenever a new idea strikes them.

LITERATURE.

The Architect's, Surveyor's, and Engineer's Compendium. Price 3s. 6d. London: E. Marlborough and Co., 51, Old Bailey, E.C.

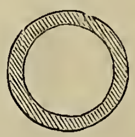
Of its kind this is about the best and most elaborate professional office diary that we have seen, and should prove exceedingly valuable and handy to architects and surveyors. It is specially ruled as a professional diary, and contains note book, certificate record, cash book, ledger, mortgage register, and rent insurance register. A map of London showing the boundaries of the surveyors' districts, etc., is an addition to the previous year's diary, and numerous other improvements have been made, such as the extension of the directory of manufactures, which contains illustrated and priced catalogues of ironmongery, brick, tile, and other goods, arranged under sections. The architect will find some useful tables of safe loads on riveted iron and steel girders of different forms, also on rolled joists and cast iron columns. A fund of information is also given on lime and cements, timber, stone, etc., written in a very practical style, besides other matter usually found in publications of this kind.

Read

WATER GAUGE GLASSES.

Steam users are sometimes troubled and put to considerable expense by frequent breakage of water gauge glasses. Sometimes tubes will break one after another after being in use only a few hours. One particular set of fittings occasionally is found to be repeatedly requiring a new tube inserting, owing to fracture of the glass, while glass tubes of the same make and quality will last an indefinitely long time in other fittings in the same range of boilers, worked with the same water and under similar conditions. In other cases tubes are continually fracturing after being in use some five or six weeks only, and, on removal, are found to have become wasted exceedingly thin. Fig. 2 illustrates a case of this sort, where tubes could not be kept in work more than seven or eight weeks without fracturing. The thickness of the tubes, when first inserted, was fully $\frac{3}{32}$ of an inch (see fig. 1), but this thickness was reduced to less than $\frac{1}{32}$ when the glass failed, after working about six weeks, the wasting of the tube being quite uniform. In another case, which we illustrate in fig, 3, the action was more local and peculiar. In this instance the portion of the glass tube which was

Fig. 1.



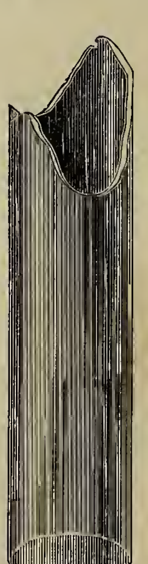


Fig. 2.

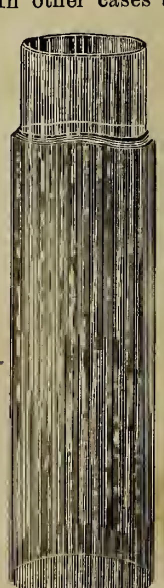


Fig. 3.

continually in contact with the water did not appear to suffer any reduction, but the top of the tube in the steam space became furrowed and grooved, either by the action of the steam or by the water of condensation in the top of the glass trickling down the upper part of the tube, which was furrowed down to the water level.

It has been thought by some that the water must have some peculiarly corrosive properties to account for this destructive effect on the glass tubes, and that some kind of acid (such as hydrofluoric acid for instance, the vapour of which has a strongly corrosive and solvent action on glass, and is used for etching) must by some means have been formed, or in some manner found its way into the feed water. Although it may perhaps be possible, where the feed water is slightly acidulous, as with sulphuric acid, and passes over calcium fluoride or fluorspar, such as is found in Derbyshire, for a little hydrofluoric acid to be formed; yet a little consideration of the chemical composition of the different kinds of glass, we think, will suffice to show that this supposition of the formation of any "glass-attacking" acid is not necessary to account for the wasting of glass water gauge tubes. Glass is in reality a compound formed by fusing together an alkaline silicate, such as the silicate of potassium, or sodium (either of which is very soluble in water) with a silicate of one of the alkaline earths, such as calcium, soluble only in acid. It is commonly supposed that such a compound is insoluble in water and acids, but it is well known to chemists that glass is more or less soluble in many compounds, and there are many determinations which on this account cannot be made in glass vessels. Strong solutions of caustic soda have a wasting effect on glass; and where this is used in boilers for preventing incrustation or corrosion, there is little doubt that it will have an effect on the tubes of the glass water gauges. Pure distilled water has a solvent action on most things, even on metals, as is evidenced by the rapid wasting which takes place in the tubes of surface condensers; and with some kinds of glass containing a large proportion of the more soluble compounds of which glass is formed, it is readily conceivable that the water of condensation (in reality distilled water) which is formed by the condensation of steam in the upper part of the glass tube, trickling down to the water level, may have the effect of dissolving small portions of the alkaline silicate in the glass, and gradually forming the furrows and causing the wasting illustrated in fig. 3. Some kinds of glass are undoubtedly much harder, and resist the action of water and other fluids much better than others, and we think it may be taken generally, that when trouble such as we have referred to is experienced by the wasting of gauge glasses, the fault is due more to the quality of the glass used than to any peculiarity or corrosive properties in the feed water. In the case above referred to, where the glasses became worn out every few weeks, the feed water was of very good quality, and had no corrosive effect whatever on either boiler plates or fittings.

[illegible]

The higher pressures to which boilers are now worked, and the consequent higher temperatures of the steam and water compared to the pressures and temperatures in vogue 15 or 20 years ago, may with some amount of probability, we think, be regarded as one cause of the more rapid deterioration of glass water gauge tubes, when it is borne in mind that most chemical reactions are greatly accelerated and intensified by increase of temperature. Where the tube of one particular set of fittings only in a range of boilers is continually breaking soon after being put in, it will generally be found to be due to the bad alignment of the upper and lower fittings, *i.e.*, not being truly in line with each other, causing a cross breaking strain to be put on the glass tube, when the glands come to be properly screwed up. This is of course a mere matter of manipulation and careful fitting of the gauges.

Glass Breaking thro defective alignment

The writer has seen glass tubes broken repeatedly, in cases where boiler compositions have been used, which have caused an accumulation of sediment in the bottom of the glass. This sometimes chokes up the bottom passage, and the water level in the boiler is falsely indicated in the gauge, the water in which becomes cool, and causes partial condensation of the steam above, which gradually fills up the glass. Under these conditions, if the bottom tap be suddenly opened, the deposit and comparatively cool water in the gauge glass will be suddenly emptied, and the glass tube will fracture with a loud report.

We believe there is no economy in using cheap or rather low-priced water gauge glasses, and we certainly think it the best course in this matter to adopt a good glass, made by a good reliable maker, even though the first cost may be a little higher.

HOT AIR ENGINES.—I.

Inventors as a rule appear to turn their attention in one particular direction at the same time, as if by mutual consent, so as to increase the interest taken in some machine considerably above that of all others, until the height of the wave (as it may be termed) is reached; then the prominence given this machine gradually subsides, and the thing slumbers for a while awaiting the recurrence of an inflation. With hot air engines this has been markedly so, and from the recent quietness in this field, and the slight signs that attention is once more being turned in this direction, it is not at all improbable this class of motor will again, very shortly, receive a fresh impulse towards notoriety. That being so, it will not be amiss to point out the limits of the efficiency of the hot air engine, the practical obstacles not yet surmounted before those limits can be reached, and the general direction in which previous inventors have worked.

A hot air engine is a motor in which the active agent is atmospheric air heated directly in a furnace, or indirectly, in a heater over a furnace, or both, a portion of the air sometimes being used for the combustion carried on in the furnace. A hot air engine is therefore quite distinct from a gas engine, in which all the air is required to produce the explosive combustion of the gas used as the heating agent.

As only ordinary atmospheric air is required for the active agent in these motors, there has been an enticing simplicity about the idea, and consequently many inventors, capable and otherwise, have given years of their lives in trying to produce a satisfactory machine. This was particularly so in the infancy of the steam engine, when that motor only showed a low efficiency; but in recent years it has become apparent that for some time to come the hot air engine must have very circumscribed limits of usefulness, as several practical difficulties prevent it competing with steam or gas engines, except in isolated positions, or where poor attention only can be given to the maintenance and manipulation of a motor, or where small powers are required. There are then uses to which hot air engines can be put, and there is no doubt about there being a good opening for such a simple, quiet, safe, and automatic motor, providing it can fulfil all practical requirements.

Treating first the efficiency of hot air engines, theoretical considerations alone point to a very high per centage. Thus: if the temperature of combustion in the furnace be 3,000° F., and the atmosphere at 60° F., and it were possible to work to these limits, the theoretical efficiency would be

$$\frac{2{,}940^\circ}{3{,}000^\circ + 461^\circ} = 80 \text{ per cent.}$$

The first reduction on this must be made on account of the temperature of combustion not being the actual temperature of the working air, which is usually about 1,500° F., with a temperature of exhaust of about 100° F., from which it will be seen the efficiency cannot exceed $\frac{1{,}400^\circ}{1{,}500^\circ + 461^\circ} =$ 72 per cent.

For the purposes of comparison, the efficiency of the best steam engine may be taken as not more than $\frac{300^\circ}{400^\circ + 461_\circ}$ or about 35 per cent., assuming 400° F., the practical highest limit, and 100° F. as condenser temperature.

APPLIED MECHANICS.

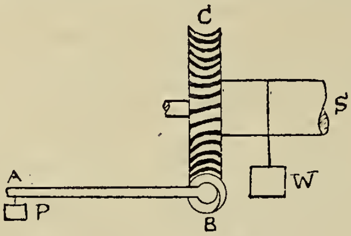
ELEMENTARY STAGE.

7. Explain, with a sketch, the manner in which the principle of work is applied in determining the relation of P to W in the case of the endless screw and worm-wheel.

The lever handle which works the screw being 14in. long, the number of teeth in the worm-wheel 20, and the load being a weight of 1000lb. hanging upon a drum of 12in. diameter on the worm-wheel shaft, find the force to be applied at the end of the lever handle in order to support the weight.

In the sketch a lever A B is attached to an endless screw at B, which gears with worm-wheel B C, so one revolution of the lever rotates the worm-wheel through one or two teeth according as the endless screw is single or double threaded; the rotation of the worm-wheel winds up the weight on the axis S of the worm-wheel.

Let the lever handle A B = R, P = power applied, r = radius of worm-wheel shaft S, n = number of teeth in worm-wheel,



W = weight to be lifted on worm-wheel axle S, b = number of threads on endless screw (if it is a single thread, $b = 1$), the work done by P in one revolution of the lever handle = P 2π R. For one revolution of the worm-wheel, W is raised to a distance $2\pi r$, therefore work done by W in this time = W $2\pi r$ (1). For one revolution of the worm-wheel the lever handle makes $\frac{n}{b}$ revolutions, therefore work done by P in $\frac{n}{b}$ revolutions of the lever handle is $P\,2\pi R\frac{n}{b}$; equating this with (1) we get

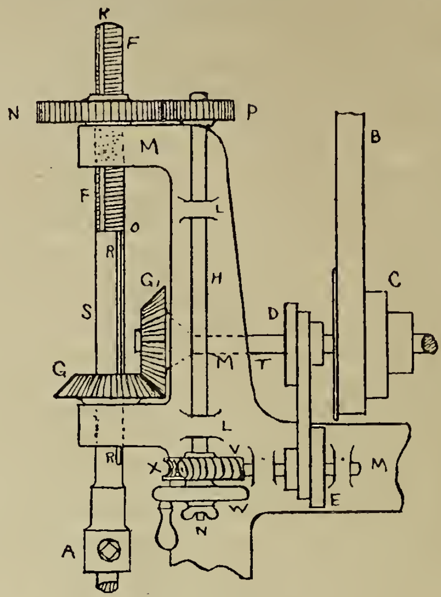
$$P\,2\pi R\frac{n}{b} = W\,2\pi r \quad \therefore \; P = \frac{W \times r \times b}{R \times n}$$

In the example W = 1000, R = 14, $r = 6$, $n = 20$, $b = 1$ (the thread being assumed single). Substituting these values we have $P = \frac{1000 \times 6 \times 1}{14 \times 20} = 21\frac{3}{7}$lb.—G. W. W., Manchester.

ADVANCED STAGE.

27. Describe the construction and action of mechanism for obtaining the "feed" in a drilling machine, showing the manner in which the rotation of the drill spindle and its advance take place simultaneously.

The drill spindle S is driven by the two bevel wheels G G^1, the wheel G^1 being keyed on the horizontal shaft T, which is driven from a countershaft by the belt B and cone pulley C. The wheel G fits easily on the spindle, and the key by which the latter is driven slides easily in the long keyway R, so that the spindle may be rotated by the key in the wheel while at the same time it is free to slide through it under the action of the feed-screw F, which is operated as follows:—If desired to feed by power the small belt is slipped on the cones D and E, thus revolving the worm-wheel X by means of the tangent screw V, and consequently the vertical spindle carrying the pinion P, which gears with the wheel N. This wheel slips easily over the feed-screw F, but is keyed on it in the same way as the bevel wheel is on the drill spindle, viz., by an easy fitting key and a long keyway. The feed-screw works as in a nut through the casting M, and raises or feeds the drill spindle to which it is attached by a joint at O. Thus, when the wheel N is revolved, turning with it the screw F, by means of its key, the screw works through the casting M and advances the drill spindle, being allowed to do so by its long keyway. If it is required to feed by hand, the wing-nut N is tightened up, and the vertical spindle is revolved by the hand-wheel W, when the feed takes place as before described.—A. G. K.

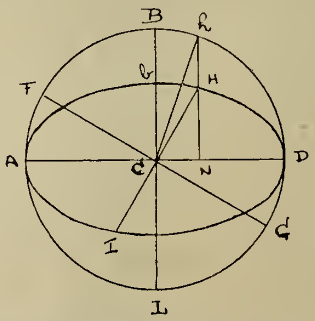


[Good answers from G. W. W., A. G. C., H. G., Y., etc.]

HONOURS STAGE.

47. Show a method of obtaining a comparison between the angular velocities of two axes inclined at a given angle and connected by a Hooke's joint. By what arrangement of a double joint can the above inequality be got over? Explain the action in the altered form of construction.

Let the plane of paper be perpendicular to driving axis, and let extremities of driving arms trace out circle A B D. Let the ellipse A b D be projection of path of followers' arms on the same plane, and let δ = acute angle between axis, then b C = B C cos δ. Let F C G be branch of medium connected to drivers' axis, then the branch connected to follower will be H C I, as its projections will always be perpendicular to F C G. Let χ = angle turned through from initial position of follower = L C G = D C H, and



let β be corresponding angle turned through by follower = h C D,

$$\therefore \frac{\text{angular distance turned through by driving axis}}{\text{,, \quad ,, \quad following ,,}} = \frac{\chi}{\beta} = \frac{\tan\chi}{\tan\beta}$$

$$= \frac{HN}{hN} = \frac{bC}{BC} = \cos\delta. \quad \therefore \; \tan\chi = \cos\delta \tan\beta.$$

By using two Hooke's joints connected together, driving shaft and driven shaft making equal angles with an intermediate shaft, the angles being on opposite sides of intermediate shaft, the inequality is got over.—G. W. W., Manchester.

ELEMENTARY STAGE.

12. Explain the use of an air vessel in connection with a force pump. Sketch a section through a double-acting force pump, showing the valves and the connection of the pump with the air vessel, and explain the action of the pump.

ADVANCED STAGE.

30. Draw the bending moment and the shearing stress diagrams

for a beam 12ft. long, supported at both ends, and loaded with weights of four and six tons at distances of three and eight feet respectively from one end of the beam. Explain fully the mode of arriving at these diagrams.

TESTS OF BOILER STEEL.

Some weeks ago (see *Practical Engineer*, Nov. 18) we described very fully the construction of a bleaching kier made by Messrs. Jos. Adamson and Co., Hyde, for Messrs. F. W. Grafton and Co., Accrington, in which the ends, made of one plate, are cambered to the extent of 18in. The operation of bending this plate is performed by a hydraulic ram, fitted with a cast iron cap, curved to the desired radius, whilst the plate is red hot, and the work is so successfully performed that the plate, which is $\frac{9}{16}$in. thick, is left free from the slightest trace of wrinkling. We described this result at the time as a "feat in boiler construction," and such it deserves to be considered. A correspondent signing himself "Kier," asked if we could get particulars of the behaviour of the steel, after bending, in the testing machine, and through the courtesy of Messrs. Adamson we are now enabled to give these particulars :—

ULTIMATE STRENGTH.		EXTENSION IN 8in.		
Plate No.	Per sq. inch.	Inch.	Per cent.	BENDS.
37	28·97 tons	$2\frac{5}{16}$	28·9	Good.
38	27·74 ,,	$2\frac{5}{16}$	28·9	,,

The tcsts were made by the Bolton Steel and Iron Company. It would be interesting to compare the above figures with a test of the plate before being cambered with the hydraulic ram, but this we have no means of doing.

COMPRESSED AIR POWER AT BIRMINGHAM

Important progress, writes a correspondent of *The Engineer*, has been made with the Compressed-Air Power Works. The works on the site being nearly complete, and a large quantity of material for the main laying provided, the money deposit required by the Corporation was on Thursday fortnight paid over to the borough treasurer by Mr. Bennett, the secretary, and on Friday morning the official order to commence laying mains was received from the borough surveyor. Within a couple of hours of receipt of the order the men were at work on the first section of the main in Artillery-street and Wolseley-street. The engine work is also rapidly progressing, Messrs. Fowler and Co.'s men have been for some days engaged upon the erection of the first of the 1,000 horse-power air-compressing engines. Prior to being sent off from Leeds, this engine was tested under steam at Messrs. Fowler's works by Mr. Sturgeon, the engineer of the company, Professor Henry Robinson, the consulting engineer, and Mr. Wilson, of Belfast, who made the detailed designs of the engines. The trial was in every respect satisfactory, and some idea of the perfection of the work and the equal balance of all the moving parts may be formed from the fact that the engines were run nearly up to full speed, and worked with great steadiness, although only resting on the timber haulks on which they were erected, without any bolting down.

An air-compressing engine of about 200-horse power has been already erected, and is in readiness to supply the first customers of the company as soon as the mains come within reach of them. The gas producers for working the boilers, and most of the boilers, are fixed and ready for working. The secretary, Mr. A. S. Bennett, solicitor, Waterloo-street, has received many applications for the new power from intending customers, and the total amount now applied for considerably exceeds 4000-horse power.

THE LARTIGUE RAILWAY IN RUSSIA.—Single rail lines have been found to answer so well in Russia that a committee of Engineers and Engineer Staff Officers was specially appointed to test the merits of the Lartigue Railway for military purposes. It was found that one mile of track could be laid by thirty men in eight hours, and that a load of five tons could be easily drawn by an ordinary horse. The raised rail is less obstructed by snow than a line on the level of the ground would be

HEATING SHOPS WITH HOT AIR.

A paper, by Mr. J. Walker, of the Walker Manufacturing Co., was read at a recent meeting of the Civil Engincers' Club, of Cleveland, on the system of heating and ventilating the company's works by hot air. The works are scattered over seven acres of land, and it became a problem of some difficulty to heat them satisfactorily. The process now employed was adopted for the work by Mr. Walker. Air is taken into a blower from outdoors, passes over a coil of steam pipe, and is forced through earthenware conduits underground for several hundred feet. Last winter the method was tried for the first time, and it was successful beyond the expcctation of its projector. In the summer the air is forced through the pipes without submission to the steam radiator, and cools the air in the different apartments several degrees below the outdoor temperature. With this system it is possible to keep an equal temperature in the works summer and winter. The advantages of the system are, economy, good ventilation, and convenience. So far as known, this method has never been used in the heating of factories before, though it has been applied to public buildings. The entrance of a strong current of warm air, and its tendency to carry up with it all impurities, keeps the factory free from smoke and the air wholesome. The pipes, in passing from one building to another, pass under open ground for several hundred feet. It was noticed last winter, when the blower was first turned on, that no heat reached the opening at the further end. As soon as the ground became heated, the air entered the building heated. When snow fell, it was melted for a space of eight feet across the pipes, which are buried four feet. In the hot weather last summer the temperature was kept at least 10° lower by means of the air blast.

RAINFALL OF 1887.

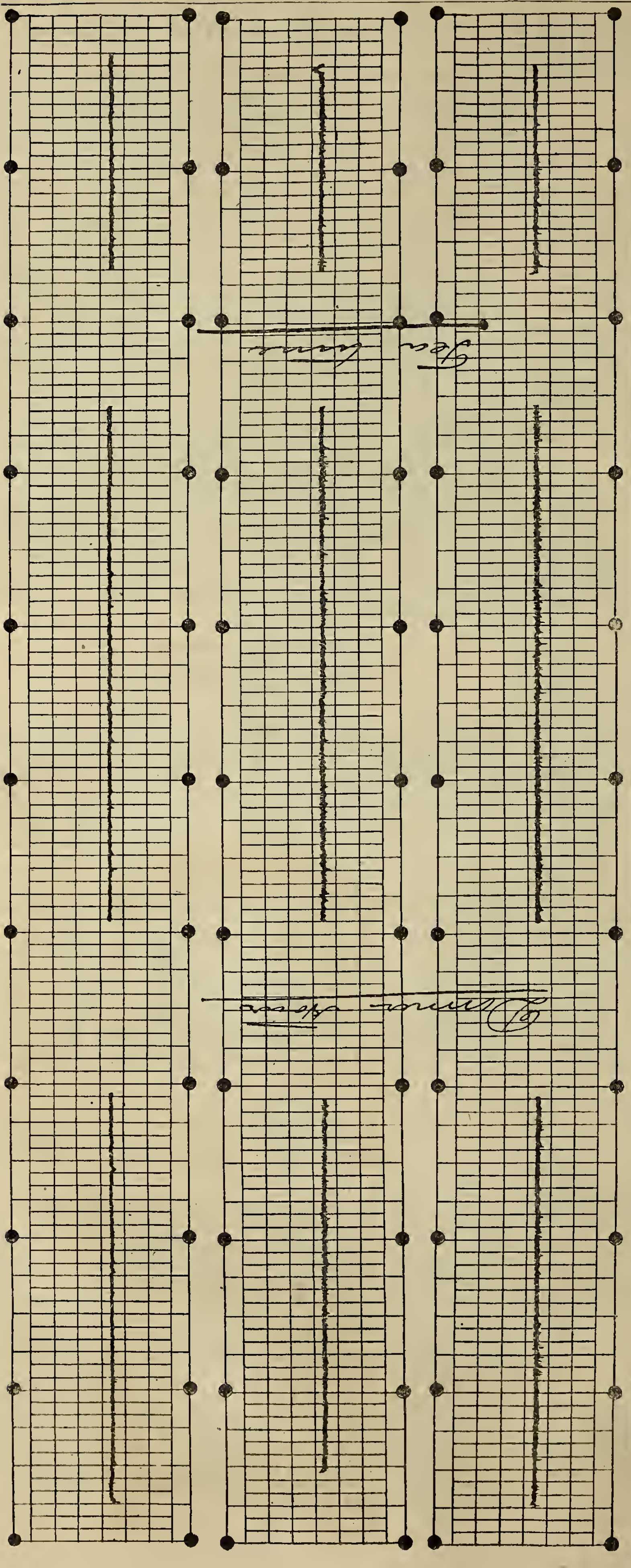
The following table shows the rainfall of 1887 compared with the average fall of the years 1870-1879, and exhibits the enormous deficiency which in some districts amounted to nearly half the average fall.

Station.	County.	1887.	Average, 1880-79.	Deficiency in 1887.	
				Amt.	p.c.
		In.	In.	In.	
London. Camden-sq.	Middlesex	19·21	27·24	8·03	29
Strathfield Turgiss	Hants	20·16	25 92	5·76	22
Hitchin	Herts	18·70	25·67	6·97	27
Diss	Norfolk	19·31	25·74	6·43	25
Okehampton	Devon	33·87	50·26	16·39	32
Ross	Hereford	22·57	31·75	9·18	29
Manchester	Lancashire	21·71	36·24	14·53	40
Huddersfield	York	19·49	32·13	12·64	39
North Shields	Northumberland	23·92	28·02	4·10	15
Jedburgh	Roxburgh	22 27	28·32	6 05	21
Seaforde	Down	24 66	41·67	17·01	41

INDIAN INK DRAWINGS.

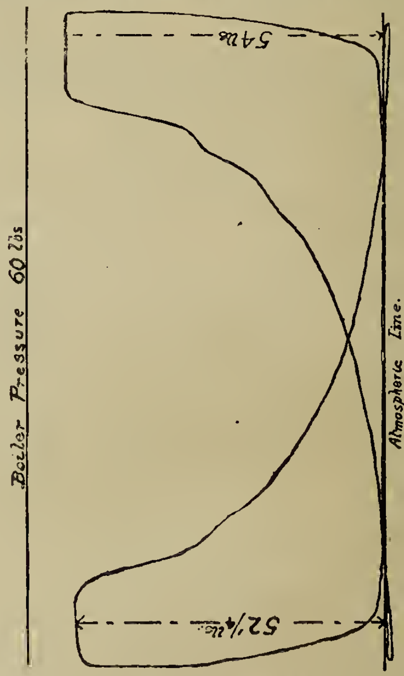
To fix Indian Ink Drawings, especially when in a drawing of a building or machine, it is desirable to paint in water colours over the outlines, without thereby causing the outlines to become blurred and indistinct ; it will be useful to have a simple method of rendering drawings in water colours safe against water, such as that set forth by Dr. H. Precht, in the German *Engineers' Weekly Review* (*Wochen schrift des Vereines der Deutchen Ingenieure*). It is a fact known in photography that animal glue, with potassium bichromate, after being exposed to the action of sun-light, becomes impermeable to water. If, therefore, in rubbing the Indian Ink (which has been found to contain, according to the latest investigations, not vegetable, but animal glue, as binding material), one uses instead of water a diluted solution of potassium bichromate, containing about 2 per cent. of this substance ; the lines, after exposure to sun-light for one or two hours, will not become blurred if printed over in water colours.—*The Indian Engineer.*

Read



ENGINE DIAGRAMS.

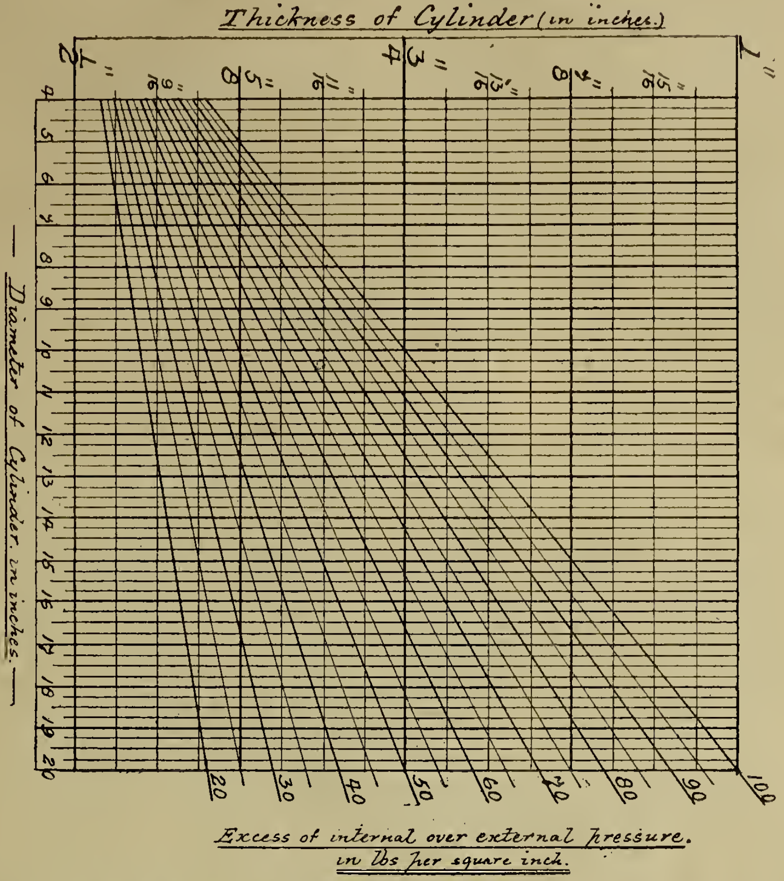
In our issue for April 29th, 1887, we gave a two-page illustration of the engine made by Messrs. Hick, Hargreaves, and Co., Bolton, which was used to drive a portion of the machinery at the recent Manchester Exhibition. The engine is of the single cylinder Corliss type, diameter of cylinder 18in., stroke 4ft., and running at 60 revolutions per minute. The diameter of rope pulley was 20ft. Messrs. Hick, Hargreaves and Co. have supplied us with a set of Moscrop recorder diagrams taken from this engine, and we have reproduced them herewith in order to show the degree of steadiness in running attainable by an engine of this class. The diagrams cover three days in August, beginning about 10 o'clock each morning and terminating a little before eight in the evening, allowing about an hour for dinner and half an-hour for tea. The vertical lines mark divisions of five minutes of time, and the heavy dots show the hours. The diagrams have been taken out of the book haphazard and may be taken as fairly representative of the average running of the engine ; and astonishing as the steadiness appears, the diagrams are not so good as others that we saw from the same engine



The conditions for steady running at the Exhibition were not by any means so favourable as in a mill, as in the first place the variations of the steam pressure were considerable, and secondly, there was a common exhaust pipe to all the engines in the building, and hence the back pressure at times rose excessively, and at other times fell considerably, according to the number of engines at work. The load on the engine was also very changeable, there being little steady machinery such as cards, frames, scutchers, or dynamos, and more than the ordinary share of mules, which are proverbially an unsteady load. In spite of these drawbacks, we think the running was remarkably good, and shows that the governors are quite competent to deal with a variable load. We also reproduce a set of indicator diagrams from an exactly similar engine of the same dimensions, working at the Saltaire Exhibition, where the conditions of load and steam pressure were more uniform than at Manchester. There is a considerable difference between the boiler pressure and the initial pressure on the piston, but this, no doubt, is fully accounted for by the very light load which was on the engine. With a heavier load we should expect to get much nearer the boiler pressure. Perhaps some of our younger readers will work out the apparent water consumption of this engine.

With Heavier load expect to get
Nearer Boiler Pressure

GRAPHIC DIAGRAM FOR THICKNESS OF CYLINDERS.



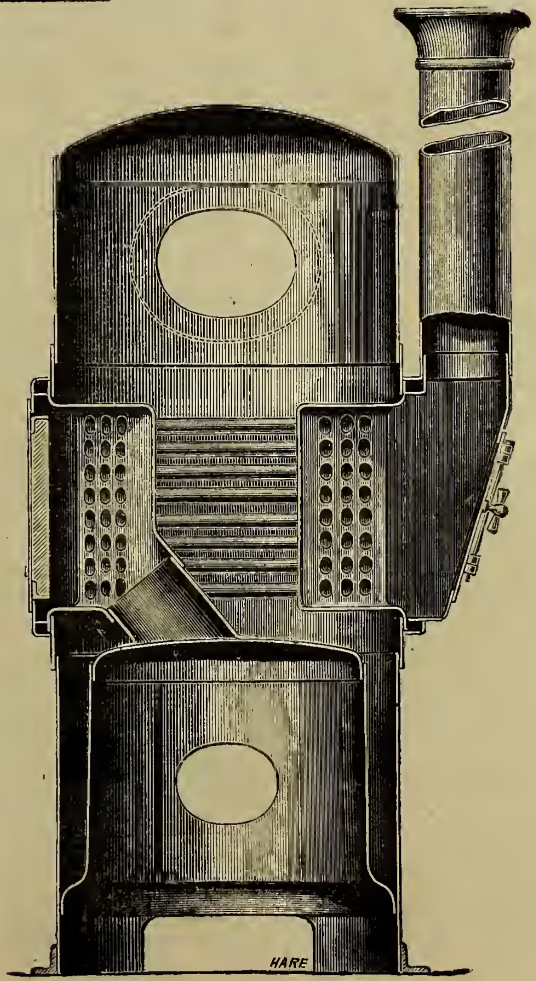
Read

The above diagram gives, at a glance, the thickness required for a cast-iron steam cylinder of any diameter, and for any pressure up to 100lb. per square inch.

Example (1).—Required the thickness of a cast-iron steam cylinder whose diameter is 10in., for a pressure of steam of 50lb. per square inch. The line representing 10in. or the lower scale intersects the diagonal line for 50lb., exactly at the line marked ⅝in. ; so that ⅝in. is the thickness required.

Example (2).—Required the thickness where diameter = 20in. Steam pressure 50lb. Answer ¾in. thick.

THE ESSEX VERTICAL BOILER.



The vertical boiler of a few years ago was a most inefficient steam raiser, and as there were very few makers apparently inclined to attempt to improve upon the design, it was branded as a low type of boiler, notwithstanding many evident advantages for certain positions and classes of work. The last few years, however, have been productive of many improvements in this class of boiler, with the result that its steaming qualities have been amazingly augmented, and now its efficiency and accessibility for cleaning and repairs are scarcely inferior to the best boilers of any other type made. Messrs. Davey, Paxman and Co., Colchester, showed so long ago as 1870, that it was possible to make a good steam producing vertical boiler, and the same firm have now introduced the boiler illustrated above, which may claim to satisfy all the requirements that may reasonably be demanded of it. The boiler has a combustion chamber and a smoke box let into the shell, opposite each other, and connected by curved tubes. The smoke enters the combustion chamber through a flue bent at an angle from the top of the fire box, and thence through the curved tubes to the smoke box and so to the uptake. The smoke box and combustion chambers are made of mild steel, pressed in one piece, flanged and riveted to the shell ; this is a remarkably good job. In plan they are shaped somewhat like the letter V, the two flat sides receiving the ends of the curved tubes being radial from the centre to the shell of the boiler. The tubes are curved to a greater radius than the shell, and may thus be drawn or inserted as required, without disturbing any other part of the boiler. The combustion chamber is closed by a door lined with fire brick, and the smoke box cover is also fitted with a door. These doors give ready access to the tubes for cleaning. From this construction it will be seen that considerable heating surface is obtained, none of which is in the steam space, and further, the draught which is necessarily rapid in a vertical boiler is thoroughly broken up, and in its passage through the tubes the heated smoke naturally impinges on the outer sides, and so cannot escape without giving up its heat. Another very important advantage derived from the use of curved tubes is that expansion and contraction to a reasonable extent may go on without injuring the joints in the tube plates, and so producing leaky tubes, with the constant need for tightning up, which is so common when straight ones are used. Every part of this boiler is easy of acccss, not liable to get out of order, nor expensive to make, and hence Messrs. Paxman and Co. may be congratulated on producing a very creditable, well designed, vertical boiler.

FAULTS IN CYLINDER DESIGNING.

One of the most glaring faults in the design of steam cylinders, especially noticeable in slide-valve engines, is the envelopment of the body of the cylinder for a large portion of its circumference with the exhaust passage. Experience and theory alike point to the advantage to be gained by enveloping a steam cylinder with a jacket containing steam of a temperature higher than that of the working steam within the cylinder, and by just as much as this steam or hot air jacketing is beneficial in securing greater economy in working, by so much is an exhaust steam jacket harmful, and productive of very serious loss, both directly and indirectly.

In the first place let us consider what the exhaust from a steam cylinder really is. It is not dry steam, for, if it were, its low conductive power would render it comparatively harmless. It is a mixture of steam and hot water, and the water entrained with the steam is in what may be termed a critical condition; that is to say, it is only a trifle below the boiling point for its pressure, that of one atmosphere absolute, and the addition of heat would raise some of it to steam again. As a matter of fact, this extra heat is very readily absorbed by the fine particles of water contained in exhaust steam, and further, it is in most cylinder designs just at hand to be absorbed. Now the latent heat of steam is very great, and the absorption of heat from the hot wall of the cylinder by the steam escaping along the contiguous exhaust passage is something enormous, for every particle of water escaping at a temperature of 212° may only be raised, it is true, to steam at 212°, but the heat necessary to effect the change of condition to steam, at only the same temperature, is no less than 966 units per pound.

The cooling effect on the internal walls of the cylinder by the re-evaporation of the exhaust is bad enough, but not easy to be avoided. There is, however, no necessity to intensify the evil of cylinder condensation by the external addition of a jacket of exhaust steam, the very worst possible material. When necessary to carry the exhaust passage round, or partially round, the working barrel of the cylinder, a core should invariably be introduced in the casting, so as to separate the exterior of the cylinder at least half an inch from the wall of the exhaust passage, and this core space may be either simply closed up, or if, as in a locomotive, it can be open to a hot smoke-box, it is possible that good might accrue from circulation through it of the hot gases of the smoke-box. It is bad practice to jacket a cylinder, with the steam afterwards to work in the cylinder, but it is infinitely worse to jacket by exhaust steam; better far to put a closed water jacket about the cylinder than do so.

It is, nevertheless, a fact, and one which has caused us much surprise, that many men who ought to be scientific engineers, considering the positions they occupy, are of the opinion that an exhaust jacket is better than a mere air jacket, for, argue they, is not the exhaust steam at a higher temperature than the air? They entirely overlook several points: first, that an exhaust jacket is constantly replenished with a supply of moist, wet steam, at a temperature much below that of the boiler steam in the cylinder, while a closed air jacket contains a few cubic inches of air heated up once for all. Second, that the conductivity of wet steam is enormous, and that of dry air almost *nil*, even supposing the air jacket received a constant fresh supply, which it does not. Third, in heating air there is no change from a liquid to a gaseous state, while in heating water until it vaporises, the absorption of heat without change of temperature is enormous.

Apart from the direct loss due to an exhaust jacket, it must not be overlooked that the increase of cylinder condensation is cumulative in effect, and a very slight addition from a direct cooling cause may be the further cause of a very much greater loss in working, for the cooling of the cylinder increases the initial condensation. The increase in the water formed during each stroke again increases the cooling effect on the cylinder, and so on, until the amount of steam entering the cylinder is something enormously greater than can be accounted for by the indicator diagram.—*Railroad Gazette.*

IRREGULARITIES OF SPIRIT LEVELS.*

By Dr. Rieth.

Remarkable irregularities in the movement of the air-bubbles of spirit levels have frequently been observed, and attempts to explain them have been hitherto unsuccessful, the reason being that the glass of which the level is made has always been regarded as an unalterable substance. Knowing, however, that the white film exhibited by lamp glasses, when first used, consists essentially of sodium sulphate, the author thought it possible that the irregularities of spirit levels are due to the occurrence of excrescences formed in a similar manner in the interior of the tube.

The first experiments to test the accuracy of this theory proved that the excrescences that were insoluble in the mixture of alcohol and ether with which the levels are filled, were soluble in water, and that they gave an alkaline reaction. The presence of an excrescence in an emptied tube is best shown by the red coloration produced when a drop of phenolphthalein solution is poured down the interior of the tube. This red coloration, and the detection of carbonic acid in the finely pulverised glass, show that sodium carbonate is undoubtedly present, or, in other words, that the glass was made from sodium carbonate and not from sodium sulphate. In the same way, when the glass is made from the sulphate, sulphuric acid can always be detected in the aqueous extract, showing that a small portion of the sulphate has escaped being converted into silicate When the level is filled with a solution of alcohol and ether, the sodium compounds, in course of time, will absorb waters of crystallisation from the water in the liquid. Their volume is thus increased, and excrescences, insoluble in the liquid, are formed on the glass.

Having thus discovered the cause of the irregularities of spirit levels, the author attempted to remove the free alkali compound by treating cut tubes, intended for spirit levels, with hot dilute nitric acid. The glass could not withstand this treatment; it broke up into a coarse powder, and the liquid contained a large quantity of dissolved alkaline compounds. Consequently, the glass hitherto used for the construction of spirit levels must be regarded as unsuitable for that purpose. With the object of ascertaining what glass is the most suitable, a number of samples were pulverised until they passed through a very fine sieve. The powder was then treated with water. The glass hitherto used gave 50 per cent. of its weight of soluble substances, when treated 40 times with water; the filtrate still remaining alkaline. The less fusible varieties of glass gave up all the soluble substance they contained when treated four to eight times with water. On evaporating the aqueous extract in a platinum dish, it was found that no glass is free from soluble constituents. The Bohemian glass used for combustion tubes showed a loss of 2½ per cent., whilst in the case of the more fusible glasses the loss reached 8 per cent. The best glass for spirit levels is that made at the Sasava works in Bohemia. It contains 4 per cent. of soluble constituents. A number of tubes of this material were soaked for a day in dilute sulphuric acid at 100° centigrade, and were then made into spirit levels. After lying for a month, they were carefully tested, and were found not to have suffered the slightest change. The success of this experiment confirmed the author's theory that the irregularities are due not to the liquid used in the spirit level, but to excrescences formed on the glass. By employing glass of higher fusibility than that of the glass now used, the error can with certainty be obviated.

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* Institute of Civil Engineers, Foreign Abstracts.

SOME PRACTICAL NOTES ON MARINE ENGINEERING—IX.

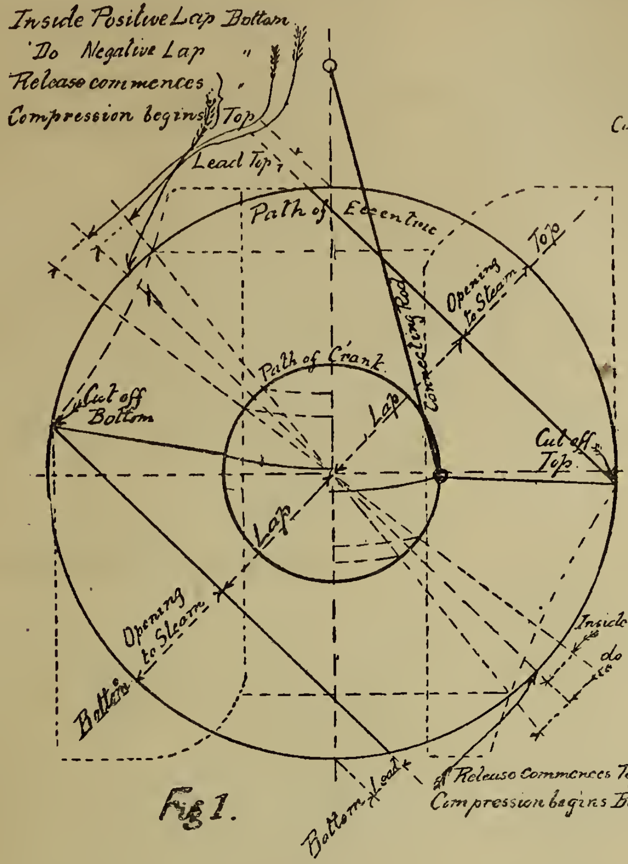


Fig 1.

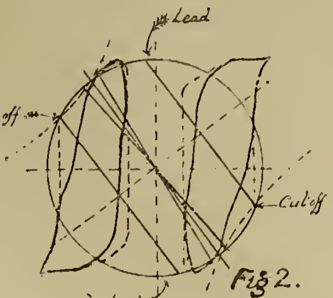


Fig 2.

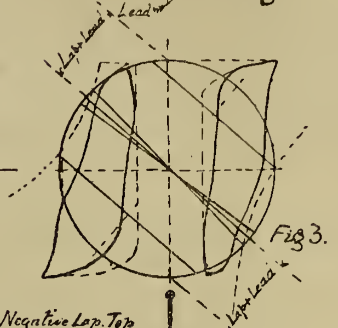


Fig 3.

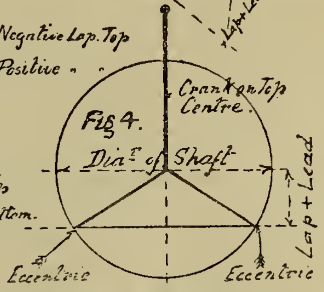


Fig 4.

VALVE SETTING.

In the fourth article of this series we promised a diagram of valve setting, and now proceed to redeem this promise. The illustration herewith shows the various points to be ascertained in the travel of a slide valve to regulate the required amount of steam to the piston. The geometrical construction may be well-known to many of our readers, it having been used for many years by marine engineers as being the most reliable and easy method of setting, and has to a large extent replaced the old method of setting by model, much in the same way as accurate drawing to a small scale has replaced the large full-sized sketches on the floor or wall. As the valve and piston do not move in the same direction throughout the whole stroke, diagrams became rather complicated, and the measurement of angles tedious and unreliable; but in the construction here shown, the lap and cut-off, &c., can easily be found by any engineer, while it is but the work of a few minutes to a draughtsman.

See table

To commence with, the size of the port must be fixed to allow of a good opening, with a velocity of steam—say 12000ft. per min. mean, taking into account a fixed speed of piston. The area of the port opening then equals $\frac{AP}{V}$, where A = area of cylinder, P = piston speed in feet per min., and V = velocity of steam; the area for exhaust to equal about twice this, so that the size of steam port is about twice the size of opening. The travel of the valve will then be the sum of the opening (including lead) and lap required for the cut-off. With the slow piston speeds once in fashion the ports were always proportioned to the area of cylinder, and engines have lately been made on the same lines, but running much faster, and the results have not been satisfactory.

To make up for the wire drawing, that is the loss caused by the gradual opening and closing of the port, the actual cut-off by valve should be a little beyond that theoretically required.

The following short table may be taken as an average from a large number of indicator diagrams:

		Cut-off by diagram		
Velocity of steam through port opening	10,000ft. per min.	x	× 1·2	= Actual cut-off by valve.
	11,000ft. „	„	× 1·22	
	12,000ft. „	„	× 1·25	
	13,000ft. „	„	× 1·277	
	14,000ft. „	„	× 1·3	
	15,000ft. „	„	× 1·35	
	16,000ft. „	„	× 1·376	

thus if theoretical cut-off by diagram is required to be $\frac{5}{8}$ of stroke, and the velocity of steam, say 12,000ft. per min., then the valve should be set to cut-off at $\frac{5}{8} \times 1{\cdot}25 = {\cdot}78$ of stroke, or if the velocity be 16,000ft., and cut-off required at $\frac{1}{2}$ stroke, then $\frac{1}{2} \times 1{\cdot}376 = {\cdot}68$ of piston stroke for the actual cut-off by valve.

THE DEPTH AND VOLUME OF THE OCEAN

At a recent meeting of the Royal Society of Edinburgh, Dr. John Murray, of the *Challenger* expedition, made a communication on "The Height and Volume of the Dry Land, and the Depth and Volume of the Ocean." According to his own investigations, the mean height of the land of the globe was 2,230ft. above the sea level, and the mean depth of the ocean was 12,480ft., or 2,080 fathoms. If the ocean were regarded as being divided into two parts by the 1,000 fathom line, it would be found that the mean depth of the area having less depths than 1,000 fathoms was 2,028ft., or 338 fathoms; or nearly the same depth beneath the sea as the height of the dry land above it. On the other hand, the mean depth of the area beyond 1,000 fathoms is 14,640ft., or 2,440 fathoms. The former area, called by Dr. Murray the "transitional area," occupies 24,000,000 square miles; and the latter area, which is the abysmal area, and is situated fully three miles below the average heights of the continents, occupies 113,000,000 square miles, or more than half of the surface of the earth. In the transitional area of the ocean there are many and varied conditions in respect of light, heat, currents, changes of level, the character and variety of the deposits, and in the animals and plants which inhabit the various parts of the region. The deposits are in most respects similar to those which make up a very large part of the sedimentary formations of the dry land. In the abysmal area there is a uniform set of conditions, the temperature being near the freezing point, with an annual range not exceeding 7° Fahr., and there being no sunlight or plant life. There is a great abundance of animal life; but the forms from various parts of the area are very similar, and unlike those of shallower waters; and the deposits, which accumulate slowly, are unlike any of the sedimentary deposits of the dry land. From Dr. Murray's investigations, it also appears that if the dry land of the globe were reduced to the sea-level by being removed to and piled up in the shallower waters of the ocean, then its extent would be about 80,000,000 square miles, and the rest of the surface of the earth would be covered by an ocean extending to 113,000,000 square miles. Again, should the whole of the solid land be reduced to one level under the ocean, then the surface of the earth would be covered by an ocean with a uniform depth of about two miles.—*Engineering.*

OUR MERCHANT NAVY.

The growth of the merchant navy of the United Kingdom during the last ten years, has been very remarkable, despite the general prevalence over that period of commercial depression. In 1877 the tonnage on the British register, including both steam and sailing ships, amounted to 6,336,000 tons. In 1886 it had risen to 7,321,000 tons, the latter figure having, however, been a decrease of 66,000 tons on the register of the previous year. Within the same period the steam tonnage on the British register increased from 2,000,000 tons to 3,969,000 tons, being an increase of about 2,000,000 tons, in round figures. The increase on the register, as a whole, was thus about a million tons, while the advance in steam tonnage, as such, was about twice that amount, which, assuming one ton of steam to be the equivalent of three tons sailing tonnage, would give a total effective increase within the ten years, equal to about six million tons of sailing tonnage. The increase of stem tonnage during the period 1840-1886 has been as under, the third column showing the actual increase of steam, and, the fourth column, the equivalent increase of sailing tonnage :—

Year.	Steam Tonnage on Register.	Increase on Preceding Period.	Equivalent in Sailing Tonnage.
1840...	87,539	—	—
1850...	167,698	80,159	240,477
1860...	452,352	284,654	853,962
1870...	1,111,375	659,023	1,977,069
1875...	1,943,197	831,822	2,495,466
1880...	2,720,551	777,355	2,332,065
1885...	3,969,728	1,249,177	3,747,531
1886...	3,961,746(-)	7,982 (-)	23,946

The United Kingdom owes 44·4 per cent. of the tonnage of the sailing and steam ships combined of the world, and 67 per cent. of the tonnage of the steam ships alone.

TEMPERING TOOLS.

If a tap or any other fine tool should by chance get too hot or burnt, do not take the tool from the fire, but shut off the blast. Get some resin, put it on the tool freely, and let it remain in the fire ten or fifteen minutes, occasionally putting on the resin, and letting the tool cool down to a good cherry red, and then immerse as above described, and your tool is as good as if it had not been overheated. I do not recommend overheating steel. It should not be heated more than a cherry red for hardening, and should be heated in a furnace if possible. If you have much tempering to do, it will pay to have one built.—*Scientific American.*

Large Cars.—The Michigan Central road is building a lot of box cars 60,000 pounds capacity.

CORRESPONDENCE.

We do not hold ourselves responsible for the opinions of our Correspondents.

EVAPORATIVE EFFICIENCY OF VERTICAL AND EGG-END BOILERS.

To the Editor of "The Practical Engineer."

Sir,—I am much obliged to "J.H." and "F." for the information contained in their answers to my query about the above in your valuable Journal. They, however, do not go far enough, and if I state my circumstances perhaps they will kindly reply further. I get certain work out of an egg-end boiler 20ft. long by 6ft. diam., which is getting past repair, but circumstances prevent my replacing it either with a similar boiler or a Lancashire boiler, as I cannot get such into the position, and the cost of taking them in in sections would be very great. I can, however, get in a boiler 4ft. 6in. diameter, and say 12ft. long, and not weighing more than 50cwt., and think I might put down two vertical boilers to do my work. I wish for advice upon the best type for the purpose, the pressure required being 60lbs. per square inch. I have to consume inferior fuel.

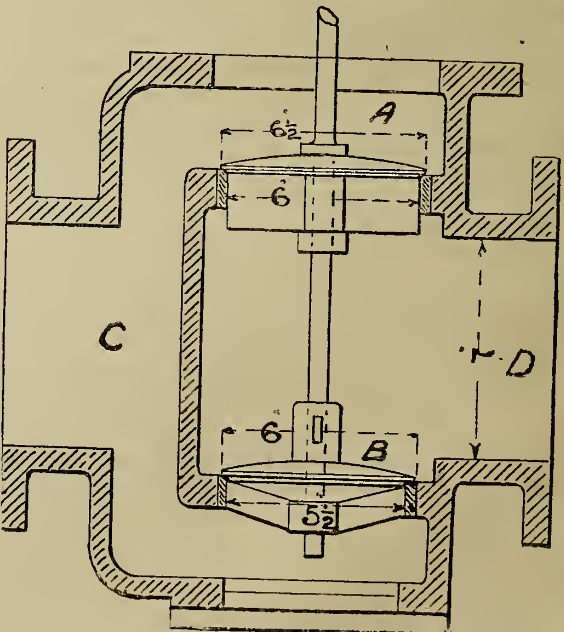
M.E.

30th December 1887.

QUERIES AND REPLIES.

Throttle Valves.—I find by experience that the common throttle valve is more effective by being made unequal in the wings, the largest area to be on the side forcing the valve open, then there is not any tendency to stick when the valve is nearly shut. I should be pleased to hear opinions upon this, and also if it is a correct way of making a valve, and the reason why. A simple rule governing the area of each wing will greatly oblige.—F.G.W.

Answer.—I cannot agree with F.G.W. that the common throttle valve is more effective by being made unequal in the wings. With such a valve as shown in sketch, there seems to be great objections as to which way the steam enters the box. If steam entered between the valves, it would press on the largest area, forcing the valve open, and obviating, as F.G.W. suggests, any tendency to stick when the valve is nearly shut. But with this arrangement instances have occurred where, owing to failure in the governor connecting gear, the valve has flown wide open when free, and done considerable damage. An instance where steam enters from the outside the valves or wings, and thus acts on the largest area, tending to press the valve down, may be interesting. Figure 1 shows such valves formed of two brass discs, A and B, of unequal diameters, the disc B being smaller, that it may pass through the seat of A. A valve of this description when raised some distance from its seat, is practically an equilibrium valve, and no difficulty is experienced in working with it; but when it is nearly closed, and when the pressures in the chambers C and D differ considerably, it is quite the reverse, particularly if the seatings are broad. In order to fix our ideas, let us suppose the valve to be of the dimensions shown in the figure, and first let us take the case in which steam enters the chamber C, at a pressure of 75lbs. per square inch, and passes out to the engine through the chamber D; then so long as the valve is at some distance from its seat the pressure on both sides of each of the discs A and B is equal, and the valve has no tendency to move: but if it touches its seat, and the pressure in the chamber D is reduced to say 50lbs., we have



Downward pressure on A = 33·18 sq. in. × 75lbs. = 2488·50
„ „ B = 28·27 sq. in. × 50lbs. = 1413·50
Total downward pressure.. 3902·00

Upward pressure on A = 28·27 sq. in. × 50lbs. = 1413·50
„ „ B = 23·75 sq. in. × 75lbs. = 1781·25
Total upward pressure... 3194·75

Difference.. 707·25

or more than 6cwt., and the nearer the valve approaches its seat the nearer does the downward pressure upon the governor rod approximate to that above given. In such cases the valve has a tendency to close, and the engine to run slow. When this happens the rise of the pressure in the chamber D, and the fall of the governor balls, raise the valve, which as soon as it is liberated from the attraction of the seating, so to speak, springs up, allowing the full boiler pressure, or a pressure approaching, thereto, to enter the cylinder. Under the influence of the increased pressure the engine bounds off, the governor balls expand, and close the valve, and so the process goes on. In one instance this affected the spinning in the mill, and caused the fracture of two of the fly wheel arms. In another case the inconvenience was even greater, for the throttle valve at times shut entirely and stopped the engine, nor could it bo raised from its seat without applying a pinch bar to the lever, unless the steam were turned off. When the steam enters the chamber D first, the effect is not generally so noticeable, the tendency being of course to open the valvo and thereby cause the engine to run faster. The seating in this case becomes the origin of a repulsive instead of an attractive force. The result is, however, the same, viz., to keep the governor in a state of continual oscillation. The difficulty may be got over in a temporary manner in several ways, such for instance as attaching a slightly elastic cotton cord. with a weight at the end, to the throttle valve lever, and leading it over a small pulley, keyed on the horizontal shaft, which in most engine houses is carried along the ceiling to connect the governor and throttle valve rods The elasticity of the cord, combined with the inertia of the weight, is sometimes found sufficient to steady the valve. Another expedient is to connect a light spring to the throttle valve lever, in such a way as to come into action as soon as the valve approaches its seat, but this is a dangerous arrangement. The proper course is to reduce the boiler pressure, or if this cannot be done on account of high pressure, steam being required for other purposes in the works, a smaller throttle valve of the piston class should be used. A too light or too sensitive governor will produce the same result if the throttle valve be large, and the boiler pressure high as compared with the pressure required on the piston of the engine. A dashpot applied to the governor will sometimes alleviate the excessive variation. Discs of equal diameters have frequently been fitted into valve boxes having large and small discs previously. They are almost perfectly balanced, and have replaced the old ones with most satisfactory results. The discs are turned a nice easy fit inside the seating rings, and the top disc has three small lugs on, to shut down against. Of course this valve is not, theoretically speaking, quite tight, but is steam tight enough for any throttle valve. Very few double winged throttle valves with mitred seatings are steam tight when tested, owing to the difference in expansion between the cast iron box and seatings, and the brass or wrought iron connecting spindle between the discs.—**Faber.**

Carding Engine.—What is the approximate horse-power required to drive a carding engine for cotton, 40in. diameter?—Kiel.

Answers.—(1) From actual indications of machinery I have found that double cotton carding engines, 52in. wide on wire, take 2 indicated horse-power. Single carding engines, self strippers, vary from 1 to 1½ horse power each.—Faber.

(2) In answer to "Kiel" I give a list of a few of the machines used in cotton mills, together with the power required to drive them:— Mule spindles = ·01 H.P. per spindle; ring throstles = ·01 H.P. per spindle; carding engines = ·75 H.P. per engine; drawing frames = ·5 H.P. per frame; slubbing frames = 1· H.P. per frame; roving frames = 1· H.P. per frame.—J.E.H.

Hopkinson's Safety Valve.—Could any reader give me a description of Hopkinson's dead weight safety valve, and show how to calculate the weight for different pressures. A sketch will oblige.—S.S.N.

Launch.—Could you or any of your readers inform me as to the thickness of steel plating used in the construction of a launch; the usual length and breadth of same, sizes of Frames, also the best method of constructing the kiel.—W.B.

Launch-Building.—Will some reader inform an amateur as to the best method of making the lap joints of small steel launches watertight, also as to the best anti-corrosive paint, as the plates, $\frac{1}{16}$in. thick, are not to be galvanised. Is there any book published on launch building, giving details, &c,—(Scantlings), J-D.

Dies for Shoe Rivets.—Could any reader inform me how the dies used for putting the screw-like marks on shoe rivets. are sunk. Any information on this matter would greatly oblige—E.B.

Electrical Resistance.—What is the simplest apparatus for measuring the electrical resistance of a metal or a liquid?—J.D.

The Odontograph.—What work contains the best practical description of the odontograph?—J.E.H.

TO CORRESPONDENTS,

J. D. Failsworth.—It is not possible to measure the electrical resistance of any body without sending a current through it.

F.W.—A rolled iron joist, 4¾in. deep, 3in. wide, and weighing 13lbs. per foot run, will bear a distributed load of 2 tons if the span is 12ft., or 1·6 tons if the span is 16ft.

Milo.—To remove paint from wood use washing soda mixed with quicklime to the consistency of cream; spread on and keep moist for an hour.

Fitter.—Your method is wrong. The lap and lead must be measured from the centre of the valve circle in the opposite direction to the crank and not along the circumference as you have done. See answer to this query on page 580.

MISCELLANEA.

Fatal Mining Explosions in 1887.—It appears that the number of persons killed by mining explosions in 1887 was 142, or 13 more than in the previous year.

The Unemployed.—"In the event of a fall of snow, labourers with shovels will be engaged at 4d. per hour." is placarded by a local authority over a great part of western London.

Shipbuilding on the Forth. — As regards the shipbuilding trade of the Forth, the past year has been exceedingly quiet, the output of new shipping being less than has been recorded for several years back.

Lubricant for Wood.—Plumbago and tallow intimately mixed is better than plumbago and oil for lubricating surfaces, when one or both of them are of wood, for the reason that the tallow will not swell the wood as much as oil.

Locomotives in the United States.—The aggregate number of locomotives upon American railroads last year was computed at 26,415, as compared with 25,937 in 1885, 24,587 in 1884, 23,623 in 1883, and 22,114 in 1882.

Contract for Steel Rivets.—Messrs. Wingate and Co., Clyde Rivet Works, have secured the rivet contract from Messrs. J. Reid and Co., and Russel and Co., for the year ending December, 1888, whose orders on hand are about 60,000 tons of shipping.

The Channel Tunnel.—The Board of Trade have intimated to the promoters of the Channel Tunnel, that if the Bill, which has been recently deposited by them in the Private Bill Office is persevered with, it will be the duty of the Government to oppose it in Parliament.

The Baldwin Works.—The Baldwin Locomotive Works have turned out 650 locomotives during the past year. A force of 35 draughtsmen is kept constantly employed, or one draughtsman to 19 engines, which is hardly more than two week's work of one draughtsman per engine.

The Bolton Strike.—The arbitrators in this strike have not been able to agree as to basis of the rate of wages, and the borough recorder, Mr. Pope, Q.C., who is acting as referee, will have to decide the matter. His decision may be expected in about a week.

Railway Mileage in America. — The Chicago *Railway Age* reports that 12,724 miles of new American railways have been laid in 1887, making the total extent of American railways 150,710 miles. The new mileage is estimated to have cost $325,000,000, which sum was largely provided by European capitalists.

The Books of 1887.—The *Publishers' Circular* states that the total number of new books, and new editions, published in 1887, is not far from 500 in excess of the books of the previous year. The number of new books is 4,410, and new editions 1,276. Of arts, science, and illustrated works, there were 115 new books, and 63 new editions.

The Melbourne Exhibition.—In order to prevent any possible misapprehension on the part of intending exhibitors at the forthcoming Melbourne Centennial Exhibition, it is officially stated that all exhibits will be regarded as in bond, and duty free, unless they enter into consumption in the colony, but when sold they must pay duty at the current rates.

San Francisco people interested in commerce are again advocating a submarine cable to the Sandwish Islands and thence to Asia. There would be two cables to the Islands, one starting at San Francisco and one at San Diego. The naval officers who have made the survey report the bottom of the Pacific as very uneven, and with a maximum depth of 27,800ft. and in some places very swift currents.

The Strong Locomotive.—Mr. George S. Strong, in a paper on the Strong locomotive, read before the Society of Arts of Boston, dwelt on the advantages of his method of constructing the fire-box so as to avoid stays, and referred to the successful use of the Samson-Fox corrugated flue, in marine boilers, and claimed that this method, which he proposes to apply to locomotives, has alone rendered possible the use of high pressure in marine practice.

Tempering Chisels.—Chipping chisels should be heated slowly at least three inches from the cutting edge, to take off the uneven strain caused by forging. Never hammer a cold chisel after the red has disappeared, especially on the edges. The corners will break off if you do. Immerse in clean soft water about two inches, and move the tool up and down slowly, keeping the point in the water at least one and one-half inches, until the water will not hiss on the tool. Then brighten and draw the tool to a sky blue.

Telegraph Wires and Birds.—A writer in the *Electrical Review* thinks that small birds may be killed by the current passing through a telegraph wire. Within the last month several small birds were seen on different occasions to perch on, and then fall off, a 19/12 bore cable. carrying a 20-ampère current charging accumulators. They could not possibly short-circuit the cables with their feet, as they are 9in. apart, and it seems incredible that the difference of potential in the short length of this cable between the birds' feet, probably an inch, could be sufficient to cause their death; but such is apparently the case.

Railways in India.—There are 14,156½ miles of railway open in India, and 2,221 miles in course of construction. Of the lines now open 7,570 miles are classed as productive—that is, commercial only—and are expected to pay 4 per cent. within five years; 317 are protective; 3,809 are protective and productive; and 1,843 are military and productive. The gauge question has been definitely settled. All the leading trunk lines with their principal feeders are laid on the broad gauge system, but the mètre gauge continues to be employed for local lines, the cheapness of construction counterbalancing the disadvantages of a break of gauge.

Collapse of a Canal Bank.—On Tuesday, the embankment of the Birmingham Canal. near the ironworks of Messrs. Hingley and Co., at Old Hill, Staffordshire, gave way; the accident was caused by the fire from some adjoining furnaces penetrating and extending to the "puddling." A tremendous explosion ensued, tearing up the embankment for fully 500 yards. The water at once began to pour through the gap, and in about an hour the canal had run completely dry between the locks above and below the scene of the disaster. Several high-roads were inundated, upwards of 50 houses flooded, and great damage done to property. It will take at least a month to reconstruct the embankment.

Power of Waves.—In a paper read by Mr. B. Haughton before the Society of Civil and Mechanical Engineers, the following instances of the power of waves were cited: At Wick a mass containing 1,500 yards of cement rubble weighing 2,600 tons was carried away. On another occasion the piece which fell under the blows weighed 1,350 tons, and waves have been know to rise to the height of 150ft. at Wick. At Dunbar dynamometer tests of wave pressure showed 3½ tons per square foot, and the average winter pressure was 0·93 tons. At Zetland blocks of stone weighing 9½ tons have been quarried out of their beds by wave action, although 80ft. above high water.

Burning of Plans and Drawings.—The destruction of the whole of the Sardha Canal project in the late Allahabad Secretariat fire is perhaps the most serious among other losses. The estimate, surveys, drawings, plans, &c., for this great irrigation work—which was to have run through Kheri and Sitapore to Lucknow from Katya in the Pilibhit district, with branches to Azingurh and Jaunpore, and by which the whole of Oudh was to have been watered—which had just been brought to completion after years of labour by Colonel Forbes, and his department, and was ready to be started the moment the order was given,—every paper has perished, it is understood, in the flames. The loss cannot be less than 2½ lakhs, taking into account only the actual cost of the work.—*Indian Engineering.*

Stretching a Huge Cable. — A remarkable engineering feat has just been carried out in China in the face of unusual physical obstacles. This was the stretching of a steel cable of seven strands across the Luan river by Mr. A. de Linde, a Danish Civil Engineer, aided only by unskilled Chinese labour. The cable is strung from two points 4,648 feet apart. The height of one support is 447ft. above the present level of the river, and the second support 737ft. above it. The vertex over the water is 78ft. The Chinese cable is the longest but one in the world. The telegraph air cable across the Kistna has a span of 5,070ft.; two similar cables cross the Ganges, one 2,900, and the other 2,830ft. A third line of 1,135ft. crosses the Hooghly, and in the United States there is one over the Missouri of 2,000.—*Indian Engineering.*

Large Turntable.—There is a mammoth turntable in operation at the Meadows shops of the Pennsylvania railroad. The diameter of the table is 193ft. It is run by a 5-horse power engine having, an 8in. by 14in cylinder, and supplied with steam from a vertical boiler. The table is automatically locked wherever it is stopped, and is released by a steam appliance that is under the control of the engineer. There are 40 tracks leading off from the pit, and in the centre of each there is a number. When a locomotive is on the table, the number of the track on which it is to run is called out, and the motor drives the table around until the number shows through a little square window placed in the side of the engine house; the engineer then stops and the table is automatically locked. A long Pullman car can be turned, or a locomotive and a Pennsylvania standard car at the same time. A complete revolution can be made in twenty- five seconds.

Raising the Locksley Hall.—The sinking of the ship Locksley Hall has been a costly affair to the Mersey Docks and Harbour Board. After deducting the proceeds of the sale of the cargo and hull, the Board has paid for raising the wreck, which was a danger to navigation, a net sum of no less than £15,831. It is remarkable that the Dock Board have not the necessary machinery in their own hands for raising sunken vessels.

SELECTED PATENTS.

APPLICATIONS FOR LETTERS PATENTS.

December 23rd.

17,658	Miners' Safety Lamps, J. Radcliffe, Manchester
17,659	Economising Fuel, J. Cooke, Stockton-on-Tees
17,663	Governors for Marine Engines, T. F. Matthews and J. Johnston, Liverpool
17,664	Economising Fuel, J. Nelson, Newcastle-on-Tyne
17,673	Machines for Shaping Metals, W. H. Allen, London
17,677	Guiding Twist-drills during Grinding, W. J. Griffiths, Greenwich
17,686	Apparatus for Starting Gas Engines, H. N. Bickerton, London
17,688	Locks, T. Burns and J. S. Dumbell, London
17,689	Steam Engines, F and F. W. Clark, London
17,692	Anchors, H. E. Newton Middlesex. (E. T. Starr, United States)
17,797	Steam Boilers, P. Hanrez, London
17,702	Turret Mountings for Guns, T. Nordenfelt, London

December 24th.

17,708	Traction Engines, I. W. Boulton, Manchester
17,717	Steam Boilers, H. B. Buckland, Newcastle-on-Tyne
17,720	Valve Gear, J. H. Holmes Newcastle-on-Tyne
17,721	Hydraulic Rivetting Machines, R. B. Smith, Glasgow
17,737	Car Coupling, J. A. Bosch, London
17,738	Petroleum Engine, G. W. Weatherhogg, Lincolnshire
17,744	Petroleum Engines, T. C. Hogg, Chancery Lane
17,747	Tubular Boilers, S. Saunders, London
17,752	Compound Engines, E. Davies, London
17,764	Packing Rings, W. Lockwood, London

December 27th.

17,773	Motive-power for Clocks, C. H. Bingham, London
17,775	Locks and Latches, W. H. Bird, Wolverhampton
17,777	Sweeping Chimneys, G. Otley, Grimsby
17,778	Shaft Fulcrum, S. C. L. Fuller. Bath
17,783	Lubricators, J. Loesewitz and G. Maass, Berlin
17,786	Roller Bearings for Mangling Machines, R. Brookbank, Bradford
17,790	Evaporator for Distilling Water, J. Reed, North Shields
17,795	Improvements in Machinery for Spinning Fibrous Materials, D. Proctor, junr. and H. McPherson, Middlesex
17,796	Armored Hose, L. Roberts, G. C. Scofield, and J. A. Caultaus, New York
17,797	Spiral Springs, L. Roberts, G. C. Scofield, and J. A. Caultaus New [York
17,798	Grinding Mills, H. H. Lake, London. (H. H. Coles, United States)
17,803	Railway Fish Plate, W. Bayliss and R. Howarth, London
17,806	Rolling Mills, R. R. Gubbins, London
17,808	Steam Separators, E. P. Stratton, London
17,809	Furnaces for Smelting Zinc, F. Rigaud, London
17,816	Ferrules, C. P. Hawley, London

December 28th.

17,818	Steam Traps, A. Bradshaw, Accrington
17,819	Safety Applicances for Hoists J. and J. and T. Barker, Manchester
17,820	Feathering Gear of Paddle-wheel, J. Henderson, Glasgow
17,822	An Improved Apparatus for the purpose of obtaining a Slow Motion of the Cylinders of Carding Engines, J. W. Nasmith, Manchester
17,823	Apparatus for Sawing Metals, C. Carter and H. Haley, Manchester
17,824	Centrifugal Fans, N. Chandler, Hednesford
17,827	Back Pressure Valves, A. Bradshaw, Accrington
17,829	Threading the Points of Wood-screws, C. D. Rogers, U.S.A.
17,831	Self-adjusting Die, C D. Rogers, U.S.A.
17,832	Water Taps, R. C. Sayer. Bristol
17,836	Permanent Way for Railways, J. Y. Johnson, Middlesex. (P. Moncharmont, France)
17,839	Flexible Supports carrying Pallets, Buckets, or the like for obtaining Motive-power, Propelling, Pumping, and other Similar Purposes, J. Y. Johnson, Middlesex (J. A. Damey, France)
17,841	Rotary Engines, C. T. and A. L. Taverdon, London
17,843	Furnaces, J. G. Galley, Forest Gate
17,845	Melting Snow on Roads, P. E. Murphy, South Tottenham
17,857	Cutting Bricks and Tyles, R. Haddan, London. (E. M. Burr and J. W. Stipes, United States)
17,858	Utilising Exhaust Steam, G. S. Loudon, London
17,860	Fresh Water Supply for Ships, J. Gilmour, Glasgow

December 29th.

17,864	Pipe Joint Cutting, T. F. Fenney, Yarm
17,870	Steam Boilers, R. Orr, Glasgow
17,875	Preventing Overwinding at Collieries, A. Bertram, Liverpool
17,882	India-rubber Tyres, H. Osborne, London
17,886	Lock Nuts, E. Field and F. S. Morris; H. W. Ibbotson, Sheffield
17,888	Marine Governors, G. A. Smith, London
17,889	Supplying Petroleum to Wick Burners, A. J. Eli, London
17,890	Cast Metal Plate Work, W. Dick, junr., Glasgow
17,891	High-speed Engines, H. Jarman, London
17,896	Heating the Igniting Tubes of Gas Engines, C. D. Abel, London. (The Gas Motoren Fabrik Deutz, Germany)
17,898	Heat Generating Apparatus for Blow Pipe, G. F. Redfern, Finsbury (E. Jolicard, France)
17,903	Apparatus for obtaining Fresh Water on Ships, J. Kirkaldy, Middlesex.

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EDITORIAL NOTICES.

All communications for the Editor of this Journal should be addressed to the Manchester Office, 3, Grosvenor Chambers, Deansgate, Manchester.

Communications intended for insertion in the current week's issue should reach us not later than Tuesday Evening.

We cannot undertake to return rejected manuscripts or drawings unless accompanied by a stamped and directed envelope.

Contributors are requested to write on one side only of the paper. Sketches should be sent on separate sheets.

TO ADVERTISERS.

Advertisements intended for insertion in the current issue should reach us on Wednesday morning at the latest.

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NOTICE TO NEWSAGENTS AND SUBSCRIBERS.

Numerous complaints having been made to us by Subscribers of the difficulty they experience in obtaining copies of the *Practical Engineer* in certain districts, we have to state that the Journal can be obtained by any Newsagent through the ordinary Trade channels, and no difficulty should therefore exist in obtaining copies by order of any Newsagent.

For the information of the Trade, we may state that copies can be obtained from either of our Offices in London or Manchester, or from any of the following wholesale houses, who are also supplied with Contents Bills for the use of the Trade:—

W. H. SMITH & SON, Strand, London.
W. H. SMITH & SON, Blackfriars Street, Manchester.
JOHN HEYWOOD, Deansgate, Manchester.
ABEL HEYWOOD & SON, Oldham Street, Manchester.
J. MENZIES & Co., Hanover Street, Edinburgh.
J. MENZIES, & CO., Drury Street, Glasgow.
W. LOVE, 236, Argyle Street, Glasgow.
W. H. CLOUGH, Well Street, Bradford, Yorks,
JOHN MORGAN, Wholesale Newsagent, Bradford, Yorks.
A. G. BEACON, Pershore Street, Birmingham.
C C. ROSS, Side, Newcastle-on-Tyne.
STONEY LEES, 27, Hartshead, Sheffield.
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GEORGE BROMBY, 26, Charles Street, Hull.
THOS. WALL, *Observer* Office, Wigan.
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EDWARD KING, 37, Greyfriars Lane, Coventry,
W. THOMPSON & SONS, St. Petersgate, Stockport.
&c., &c., &c.

NOTICE.

BACK NUMBERS.—*As we have received several letters from correspondents who have found a difficulty in obtaining* BACK NUMBERS *of the* PRACTICAL ENGINEER, *we have to state that all the back numbers are still in print, and can be obtained from our office on receipt of stamps to cover cost and postage.* CASES *for* BINDING *the* PRACTICAL ENGINEER *can be obtained from the publishers, price 2s.,* POST FREE. VOLUME I., *bound in cloth, containing the numbers from March to December, 1887, can also be had, price 6s. 6d.,* CARRIAGE FREE.

STOCKTAKING.

COINCIDENT with the Christmas festivities is the performance, in the majority of business and engineering establishments, of that most necessary operation known as "taking stock." It is imperative that we know "how we stand," and hence almost before the taste of the Christmas cheer is out of one's mouth, managers and foremen and other officials are busily engaged in extra work, and have perforce to work off the recent holidays with overtime. Stocktaking is an anxious operation, revealing as it does, the fact whether one has been working at a loss or not, and hence determines in what manner the manager may meet the shareholders at the annual meeting. If there be a good profit, well and good, but should there be a loss on the year's working, the stormy scenes of the annual meeting and the angry words of the grieved shareholders must somehow be faced. The hard competition and harder times of the last few years has, we fear, produced more cases of unsuccessful working than handsome profits, and when one is worried all the year round with trying to make both ends meet and leave a little profit, it is rather hard lines to have to admit failure at the finish, and to meet the rebukes of the shareholders into the bargain. It is to be hoped that the revival of trade, at present so evident, will continue through the year, so that next year's stocktakings may be anything but an anxious time.

Large establishments are usually closed several days for stocktaking, as it is otherwise impossible to take proper account of the multifarious articles in use. A batch of men and clerks, in gangs of four and five, is usually told off for the work, the men doing the counting and weighing while the clerks enter the figures in a rough memorandum book. In this way everything in the establishment is taken a record of, from the smallest bolt up to the largest machine. Notice has been sent round beforehand to the firms supplying goods that nothing may be forwarded during the period of stocktaking, so as to simplify matters as much as possible. As may be imagined the work is not very agreeable to the men engaged in it, especially the out-door part, but this must be got through as best one may with the aid of open portable fires of the well-known kind to keep the cold out. As far as possible the articles are booked against the jobs they are intended for—each order being known by a number during the course of manufacture; as all heavy goods, channels or other iron, etc., are usually invoiced to the order for which they are intended; these can be taken into account without weighing by simply referring to the invoices. Many items such as scrap iron, coal, etc., can be estimated by throwing in a heap and taking the measurement in cubic feet; plates, bars, etc., must be measured and their weight calculated, unless the lots are mixed miscellaneously, when there is nothing for it but to weigh. Articles not ordered for specific jobs must be booked to the general account. Timber, as a rule, can be very fairly estimated by packing together closely and measuring the bulk.

The stocktaking time is generally taken advantage of for effecting alterations in the shops, or for making necessary repairs to engines, boilers, shafting, or machines; it is also the time for overhauling and weeding out all sorts of odds and ends, and discarding those not likely to be required again. The windows may be cleaned and the shops whitewashed and made trim for the coming year's work, when a new start is made in more senses than one. Of course, after the actual work of stocktaking is completed, the result has to be worked out in the office, when the various items are priced, tabulated, and calculated, and "licked into shape," and transferred from the rough books used in the works, to the permanent books of the establishment. The operation of pricing is a ticklish one, and admits of a good deal of dodging, especially if the stock is a very large one, as the articles may be entered at the maximum of current prices, and so made to show up well. It is the auditor's duty to see that this is not done, and it is not uncommon to demand of the manager a certificate to the effect that the average current prices of the day have not been exceeded.

THE DUDLEY BOILER EXPLOSION.

FORMAL INQUIRY.

On Wednesday, the 11th inst., a formal inquiry was opened at the Town Hall, Brierley Hill, near Dudley, with regard to the fatal boiler explosion which occurred there in October last, at the Leys Ironworks, belonging to Messrs. Brown and Freer. The explosion, it will be remembered, was a particularly disastrous one, seven persons being killed and as many others more or less seriously injured. The boiler which burst was of the type known as the Rastrick, commonly used at ironworks to utilise the waste heat passing off from puddling and reheating furnaces. The height of the boiler was between 17 and 18ft., and the diameter of the shell about 9ft. 4in. It was fired with the waste heat from two puddling furnaces, the heat first playing on the outside shell, and then passing through the short connecting branches into the descending T-shaped flue, from which it passed underground to the chimney. The explosion occurred from the blowing-out of two of the plates in the cylindrical portion of the shell, and, from the evidence which was tendered at the inquest, it appeared to be mainly due to the existence of an old flaw at one of the vertical seams of rivets.

The boiler was insured with the Midland Boiler Insurance Company, and was examined and pronounced in order by one of the Company's inspectors only a day or two before the explosion; a report to this effect, we believe, being received by the owners the day after the explosion had occurred.

The disaster was investigated by Mr. Watson, one of the Board of Trade surveyors, shortly after its occurrence, but up to the present no official report has been issued to the public. From the fact that a formal inquiry has been ordered, it would appear that the Board of Trade are of opinion the case is worthy of further investigation. The fact that this is the first formal inquiry which has been ordered since the passing of the Boiler Explosions Act in 1882, coupled with recent proposals of the President of the Board of Trade to make boiler inspection compulsory, invests the proceedings with more than ordinary interest.

We may perhaps explain for the benefit of those of our readers who are not familiar with the operations of the Boiler Explosions Act, that it provides for the investigation of every boiler explosion, whether fatal or not, by one or more independent engineers appointed by the Board of Trade, such investigation being termed a preliminary inquiry. Clause 6 of the act further provides that "if it appears to the Board of Trade, either upon or without such preliminary inquiry, that a formal investigation of the causes and circumstances attending the explosion is expedient, the Board of Trade may direct a formal investigation to be held;" and that such "formal investigations of boiler explosions shall be made at or near the place of such explosion by a court consisting of not less than two commissioners appointed by the Board of Trade, of whom one at least shall be a competent and practical engineer, specially conversant with the manufacture and working of steam boilers, and one a competent lawyer. The court shall be presided over by one of the commissioners, the selection being made by the Board of Trade."

The act stipulates that a full and clear report of every formal investigation shall be issued to the public, or, if no formal investigation be held, then of the report presented by the engineer making the preliminary inquiry. Up to the present, 242 Reports of Preliminary Inquiries have been published, but this, as we have stated above, is the first case in which it has been considered necessary to appoint a court to hold a formal inquiry. The commissioners appointed by the Board of Trade are Mr. Druitt Halpin, engineer, and Mr. Mansel Jones, barrister.

THE BOARD OF TRADE RETURNS.

The Board of Trade returns of the imports and exports for the past year are very gratifying reading. They show a decided increase over the figures of last year, the month of December particularly being noticeable for providing the greater share of the increase. From the figures supplied by these returns it seems certain that trade generally has taken a favourable turn, and that the long depression is fast passing away. The returns dealing with metals, especially copper and tin, show the greatest irregularity, due to the speculative character of the business done, but we have faith that behind this there is a change going on in the same direction as that unmistakeably pointed out by the year's returns in other branches of trade.

LITERATURE.

The Journal of the Iron and Steel Institute. No. 2, 1887. London: E. and F. N. Spon.

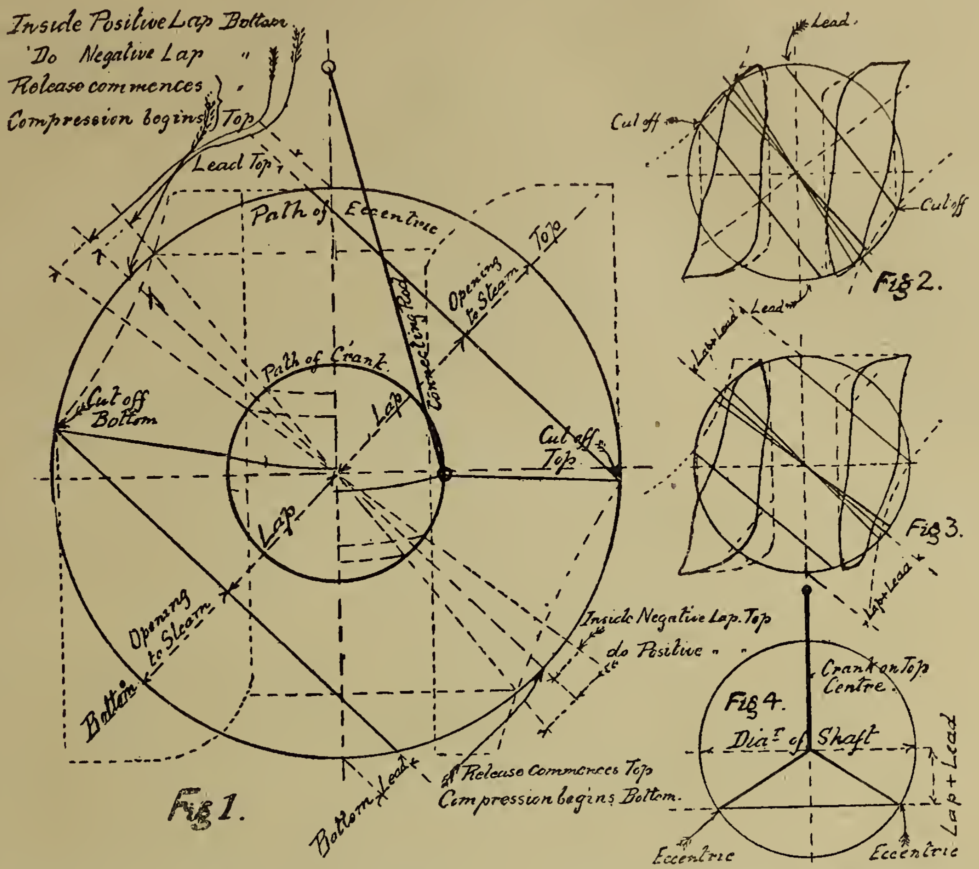
This volume of the Iron and Steel Institute contains its full share of interesting matter. The papers are those read at the Manchester meeting in September last, which were fully noticed by us at the time, and call for no further remarks. The obituary includes the names of Alfred Krupp, Essen; William Denny, Dumbarton; John Thompson, Glasgow; Wm. J. Clark, Sunderland; Eli Spencer, Wilmslow; and Titus Salt, Saltaire. A curious old pamphlet, dated 1754, has been reproduced in its original form, and is interesting reading. It deals with the case of the importation of bar iron from our own colonies in North America, and recommending that it be allowed to enter duty free for the sake of home manufacturers as well as the colonies. In a postscript it recommends that the duty on exported coal be doubled. The second part of the journal contains the usual extracts from various publications relating to the home and foreign iron and steel industries, abstracted by Messrs. Ball and Brough.

Boiler and Factory Chimneys. By Robert Wilson. Second edition, pp. 64, price 3s. 6d. London: Crosby Lockwood and Son.

The question—"What is the proper size of chimney for certain conditions of boiler or engine power?"—is one that is frequently asked, and proves that there is a demand for such a book as now lies before us. Mr. Wilson is the author of a well known treatise on steam boilers, and the notes for the present volume were intended to be added to that work, but for convenience and greater utility they have been published separately, a proceeding that will be appreciated by the majority of readers. The first chapter relates to chimney draught, and gives the usual formulæ for the calculation of

SOME PRACTICAL NOTES ON MARINE ENGINEERING—X.

VALVE SETTING. CONTINUED FROM PAGE 9.



draught, with the reasons for the same. These are stated in a practical way, and can be readily applied to any case that may come under one's notice. A table of sizes of chimneys and flues supplements this part of the book, which will be useful for reference, though we regret that the old-fashioned term "horse-power per square foot of chimney area" has been retained. Such expressions as these are quite meaningless, and ought to be relegated to the dust-heap of other useless phrases which have had their day and are now extinct. Perhaps the author has retained the term because its use is likely to survive some time yet in certain quarters. The second chapter deals with the stability of chimneys, the principles underlying which were so ably expounded by Professor Rankine. The suggestion of making an arched opening at the bottom of the chimney for the purpose of gaining admission into the flues, in preference to the too common practice of merely leaving a door in the crown of the flue, is a very good one. A provision of this kind would facilitate the making of experiments on the draught when thought desirable; it would allow of a good draught being created by a wood fire when first lighting up after the flues have been allowed to get cold, and would lead to the detection of defects in the draught which might not otherwise be discovered. Chapter III. contains a brief description of some of the more remarkable chimneys in the country; and the last chapter treats of the subject of lightning conductors. Perhaps the most important thing about a lightning conductor, and one that is oftenest neglected, is the method of making the connection with the earth. The rod should terminate in a large copper plate, and be connected to a metal drain pipe, or other similar good conductor; or, if possible, should terminate in ground that is permanently moist, and end in an iron case or copper plate. Attention to this detail is very important, otherwise the best conductor will only prove a delusion and a snare instead of a protector.

SOME PRACTICAL NOTES ON MARINE ENGINEERING.—X.

To construct the diagram draw circle equal to travel of valve; from the same centre draw circle to small scale to represent stroke of piston; with radius of connecting rod set off from centre line to crank circle the line representing distance travelled when cut-off is wanted, and project from centre to valve circle, that is, transfer this position to the travel of valve. Set off required lead, say $\frac{1}{8}$ top, and draw straight line to cut-off as shown in figure 1. Parallel with this draw line through centre to represent the inside edge of valve; again, draw parallel line for opposite cut-off—say $\frac{1}{2}$ lead on bottom. The other points are all marked on diagram which explains itself. The smaller diagram, fig. 2, shows loss through ports caused by wire drawing in a piston valve, with about 15,000ft. per min. velocity of steam—steam 150lb. The next, fig. 3, is from a slide valve double-ported intermediate cylinder, about the same velocity of steam. The result of this was that the HP. cylinder did far short of its proportion of work; the speed at the time was, however, much above the average working. The next, fig. 4, shows the position of eccentrics—supposing the diameter of circle to be the same as diameter of shaft—with crank on top centre, set off lap and lead, and transfer to surface of shaft.

The dotted diagrams on fig. 1 are purely theoretical, and merely indicate that which is aimed at, and thus form a basis for working upon, while, at the same time, serving to explain the nature of the construction. The back pressures and initial pressures (except initial of HP. valve) are dependent on the size of receivers and cut-off of other valves.

The proportion may be as follows:

Area of steam ports $= \frac{AP}{6000}$

" . opening to steam = about $\frac{1}{2}$ above.

Opening to steam or distance travelled by valve when full open $= \frac{AP}{2W600}$. where W = width of steam port, usually from ·7 to ·85 diameter of cylinder, with ordinary slide valves.

Throw of eccentric $= \frac{\frac{1}{2}AP}{6000}$ + lap and lead = ½ travel of valve, that is travel of valve = (opening to steam + lap) × 2.

To find the travel for a given opening of valve, the writer has used the construction just explained—having a standard diagram with a number of circles, all from the same centre, each representing a travel to full size, lay a straight-edge across from lead to cut-off, until the travel is found which gives the right opening. The operation, though one of trial and error, only takes a few minutes, and is very accurate.

The few following examples from practice show that the velocity through opening varies from 10,000 to 15,000ft. per min., and for the exhaust through *steam ports* from about 5200 to 8300. With the increased lead on the bottom side of valve the opening is a little more, and, consequently, the velocity of steam less than on the top; the mean of these is used in the calculation.

Dia. of Cylr	Lngth of Port.	Width of Port.	Wid of Ex-ha'st	Mean open-ing to Steam.	Mean Cut-off.	Piston Speed	Velocity of Steam Port opening.	Velo-city of Steam Ex-haust.	Tra-vel of valve
in.	ft. in.	in.	in.	in.		ft.pr.mn.	ft.pr.mn.	ft.pr.mn.	in.
27	1 7	2 single	4	1 3/16	·51	455	11,610	6,849	6½
29	1 8	2½ ,,	4	1 5/16	·54	500	12,600	6,600	4¼
30	1 5	4 ,,	–	1 11/16	·74	600	14,920	6 236	7½
36	2 4	2½ ,,	4	1⅜	·56	520	13,730	7,554	7
39	2 10	1½ doub	4½	¾	·44	450	10,540	5,270	4½
48	3 4	2 ,,	–	1⅜	·75	600	9,860	6,784	5
58	3 10	2 ,,	7	1 1/16	·45	500	13,545	7,179	4¾
64	3 9	2¼ ,,	7	1¼	·51	520	14.890	8,364	7
73	3 11	2¾ ,,	7½	1 5/16	·57	450	15.270	7,285	6½
75	4 6	3½ ,,	–	2	·74	600	12,770	7,000	6½
76	4 7	3 ,,	6	1⅝	·67	600	15,220	8,245	6½

BLOW-HOLES IN STEEL.

The presence of blow-holes in steel was at one time generally attributed to bubbles of carbonic oxide. More recently the investigations of Müller, Stead, and others have proved the cavities in steel ingots to contain nitrogen and hydrogen. Mr. W. F. Durfee has recently, says *Industries*, communicated to the United States Naval Institute an ingenious and somewhat novel view of the subject. He considers the blow-holes in ingots to be caused by air carried down into the mould by the stream of steel rushing out of the ladle. The action may be illustrated by holding a glass of water under a running tap, when the course of the bubbles may easily be seen. When the tap is turned off, the fluidity of the water instantly allows the bubbles to escape; but if the experiment be repeated with a more viscid liquid—melted gelatine, for instance—some of the air will be unable to escape. When the mass has solidified, the disposition of the bubbles will be found to be very similar to that of the cavities in a soft steel ingot. The temperature of molten steel is sufficient to expand air about seven times; while any atmospheric moisture would be converted into gases with corresponding increase of volume; so that a small quantity of air may produce a considerable degree of perosity. Mr. Durfee proposes to overcome the difficulty of producing sound ingots by making the steel sufficiently fluid to permit the escape of the air bubbles by the addition of a small quantity of aluminium. The improvement in fluidity, and subsequent solidity, resulting from the addition of less than 0·1 per cent. of aluminium to melted wrought iron or mild steel has long been known, and is practically taken advantage of in the manufacture of Mitis castings; but however beneficial, its application to ingot steel must in the meantime be limited to cases where cost is an entirely secondary consideration.

Inland Canal.—It is proposed to construct a canal from Duluth to a point on the Red River of the North, and to extend steamboat navigation 1,600 miles westward from Lake Winnipeg, where it is possible to develop wheat lands of 500,000 square miles.

MOULDING A ROPE PULLEY.

In moulding a rope pulley, three methods may be adopted The first method is to use cores to form the grooves. The cores require a specially made box, which consumes a considerable length of time by the pattern maker, in making, and when these are all put together in the mould they invariably form a fin between each core, which makes a casting very disagreeable to the eye. There is a second method in which the rim is built up of loam bricks.

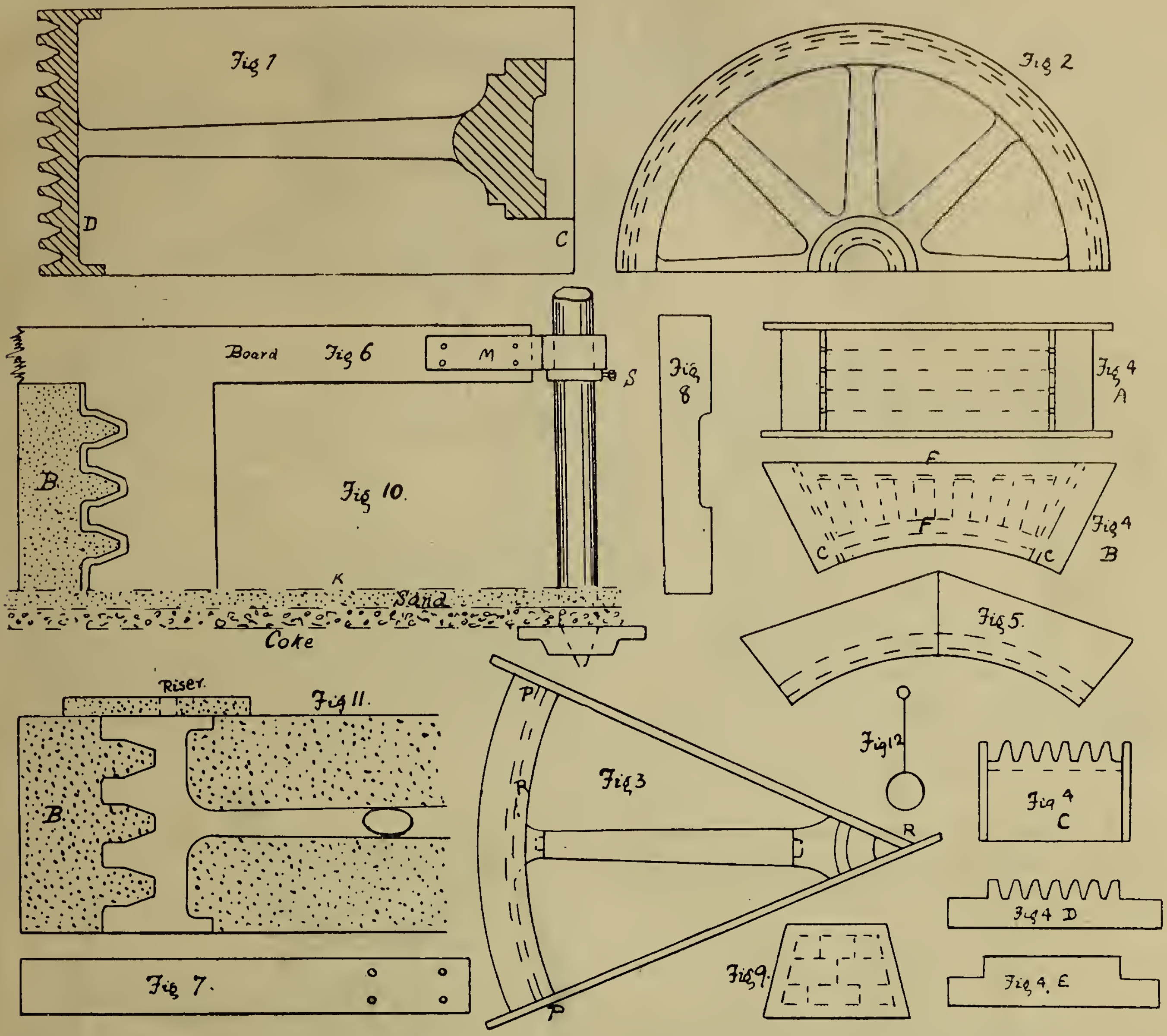
In this article the writer will describe what, in his opinion, is the simplest and truest method of moulding rope pulleys, for which a whole pattern could not be made, as taken from his own practical experience, and will take for example a pulley 15ft. diameter, having 10 grooves, and of the type shown in figs. 1 and 2. The method is applicable to all sizes of pulleys, say from 1 to 30ft. diameter, and any number of grooves. The most important part of the pattern which requires to be made is the arm core box, fig. 3. This box must be made to suit the number of arms in the pulley. Suppose the pulley to have eight arms, then the width of the box from P to P must be exactly ⅛th the circumference of the pulley. The length of the arm core from centre of boss R to rim R must equal C D, fig. 1. The arm in the box must be morticed into the rim and boss, as indicated by the dotted lines, but left loose, so that when the core is rammed in the box, the back and sides can be drawn away, leaving the arm in the centre of the core. The core is then trimmed at the boss and back. As the arm tapers from the boss, it is tapped with a mallet at the rim end, and drawn out. The core box is then complete.

We next require a core box to form the grooves on the rim of pulley. Fig. 4 A shows a plan of box, the dotted lines representing sprigs. Fig. 4 B shows a side view, the dotted lines representing the core iron with prods to hold the core together. Fig. 4 C shows end view of box. Fig. 4 D and E are strickles. If this box is, say 47in. long from C to C, which is the pitch line of the grooves, there would be required about 12 cores for the circumference; these cores should be about 8in. thick from F to F. The ends of cores fit together, according to the angle given the diameter of pulley, as shown in fig. 5, which illustrates two cores jointed together.

We next require a strickle, fig. 6, to form the grooves, which of course can be made for any number of grooves as required. We also want a strickle board to form a foundation for the rim cores to bed upon, as in fig. 7; and a core board for centre, as in fig. 8; also a covering core box, fig. 9, the dotted lines representing core irons. This core should be about 2¼in. thick, and the cores of whatever length must be made to suit the same angle as the rim cores, so as to fit each other all round the pulley. Being provided with these requisites, the moulding of the pulley will be found a very simple matter.

In the first place a hole is dug in the sand, say 3ft. larger than the diameter of pulley, in which set up a 6in. spindle with iron centre (which is a fixture when once set), and form a coke bed, as shown in fig. 10. Great care must be taken to vent the bed well with pipes about 3in. diameter. On the spindle place a loose collar, with set-screw S, which can be lowered or raised to any desired height; a loose arm M is provided, to which the strickle board can be bolted. When the spindle and centre plate are firmly bedded in the sand, the board, shown by fig. 7, may be fixed to the arm M, and the collar adjusted so that the board may strickle the sand for the rim cores to be laid upon. After strickling round, this board is removed, and another one, fig. 6, substituted and placed as shown in, fig. 10. To make the rim cores, lay the box on a level surface, as shown in fig. 4 A, and place inside the box a strong grid, with long prods, to carry the core about with when dry, as well as keeping the core together; then ram black sand in the box to cover the grid, being mindful to insert small ashes or cinders; the latter being covered, use the strickle, fig. 4 E, to strickle black sand about ⅜in. or ½in. below the grooves, as indicated by dotted lines in fig. 4 C. Then take 6in. sprigs, and thrust them in the sand in a line with each groove, to carry the loam when forming the groove, as shown fig. 4 A; next use extra stiff loam (composition, red sand, parting sand, horse droppings), and cover the sprigs, and apply the strickle, fig. 4 D, and a thinner coat of loam, which forms a clean smooth surface on each groove. The box is then taken off, and the core inserted in the stove to dry. In fig. 10, B, shows end view of the core. Assuming the rim cores are all made and dried, bolt the strickle board, fig. 6, to the spindle arm, as shown, fig. 10, and place the first core in position. Fig. 10

MOULDING A ROPE PULLEY.



shows the board bolted to the arm M on the spindle, also a core laid on the bed; the space C shows the clearance between the rim core and the board, when the cores are first laid on the bed, before the board is used. When all the rim cores are put in position the strickle should be about ¼in. from touching the cores, as shown at C, fig. 10. The next operation is to ram sand hard and tight behind the rim cores level with the top, and sandpaper the grooves all round. Some pretty stiff loam should now be applied, and worked with the strickle all round; this done, put on a very thin coat of loam. The whole should now be thoroughly dried by inserting fires, taking great care not to burn it, after which it is again sandpapered and blacked with liquid blacking, and dried again. The bed K being made perfectly straight, then commence to place the arm cores in position, these having been previously dried in the stove, and to put in the centre core and the covering cores, fig. 9, to cover the rim of pulley. Fig. 11 shows the rim struck up, also the arm cores in position, and the covering core with a riser through it. Where the metal is poured in. should be well sprigged. The metal should be run in at the boss, as it will have a better chance of spreading itself. Four risers on a 15ft. pulley will be sufficient. Wooden pegs should be inserted in the risers, and wooden gits in the runners, and the whole pulley covered with boxes, and sand rammed in to cover the pulley. When this is done, and the boxes well weighted, the gits and the pegs in the risers are taken out; the latter are covered with an iron ball, having a loop handle, as fig. 12, which are taken off when the metal has filled the mould. Pulleys of this description require to be well fed to produce a good sound casting.

1,000 H.P. TURBINE. *

The power required for driving the machinery and working the plant at the Bessemer steelworks at Terni is derived entirely from the great falls. During the past year, Messrs. Rieter and Co., of Winterthur, have erected turbines for this work to the extent of 3,000 HP., the largest being that required for the ordinary rolling mills, and which is of 1,000 HP. The system adopted is Schwamkrug's, which is well suited to high falls, working with a small volume of water. In the present case the available fall is about 590 feet = 260 lbs. per square inch. The water used per second is 19·6 cubic feet, and the effective work averages 75 per cent. of gross power. The internal diameter of the turbine is 7ft. 10½in.; external ditto, 9ft. ⅜in. Revolutions per minute: from 180 to 240. Speeds on inner periphery: 74ft. to 98ft per second; on outer ditto, 85ft. to 114ft. The turbine wheel weighs 4 tons 8½cwt.

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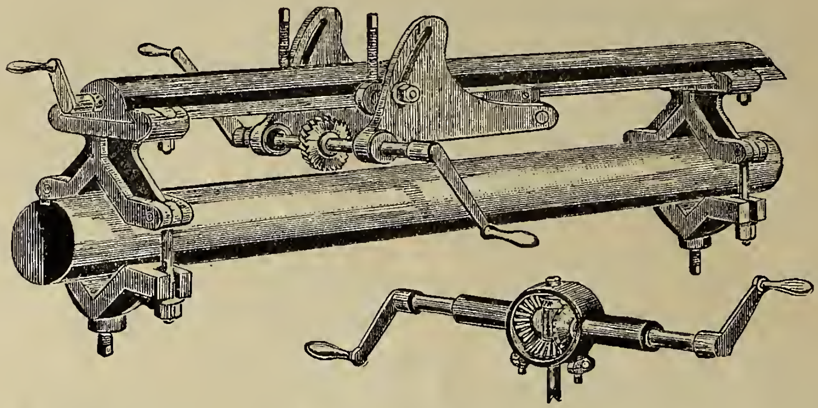
* Institute of Civil Engineers, Foreign Abstracts.

PORTABLE KEY-SEATING MACHINE.



For the illustration and description of this key-seating machine we are indebted to the *American Machinist.* The tool is a new one made by Pendrick and Ayer, Philadelphia.

The V blocks which rest upon the shaft, and to which the beam is fitted, are accurately planed, so that when placed upon a shaft, they bring the beam in correct alignment. The larger sizes are powerfully geared, and driven by round belts in the same manner as portable drilling machines. It can be attached to any sized shaft, from 1¼in. to 6in. diameter. The carriage may be used on the end of the beam in case a key seat is to be cut at the end of a shaft. The screw which feeds the carriage passes through from end to end of the beam, is turned by hand in the smaller sizes, and automatically in the larger ones. Any length of key seats may be cut by moving the machine along the shaft. That part of the carriage carrying the cutter arbor is in the form of a swinging frame, provided with a slotted arc and binding bolts, and with screws for feeding the cutter into the work.

The machine can be used under a locomotive to cut key-seats in main axle for eccentrics. In this case a yoke is used, made of steel, with two trunnion bearings, and carrying a vertical spindle with a cotter drill. This attachment is driven by three mitre gears and cranks on either side of machine. For ordinary key seating, spiral cutters are used, and are held upon the arbor by keys and collars in the ordinary manner. The machine can be used to cut keyways in propeller shafts in case of repairs, and in shops where planers are ordinarily used for key seating heavy shafts, and for many other purposes which will readily suggest themselves.

CASTING IRON UPON LACE.*

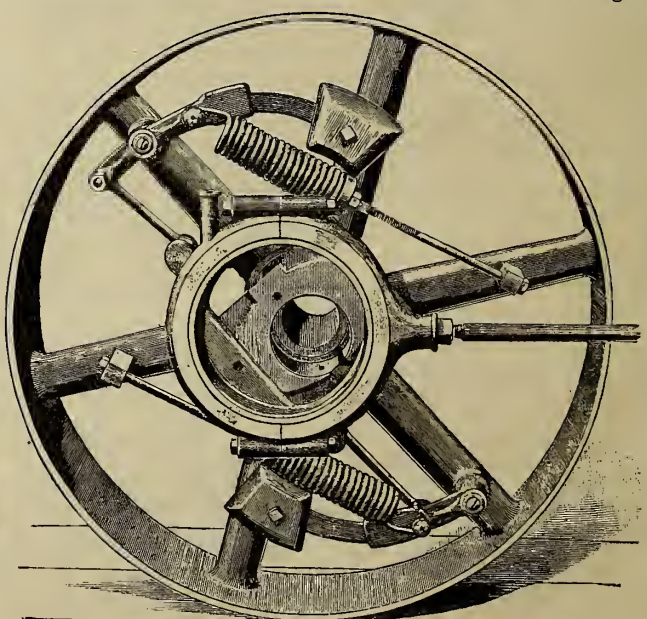
Castings have been successfully obtained from specially carbonised fabrics, without injury to them. Not a single fibre was consumed; but upon the face of the casting there was found a sharp and accurate reproduction of the design, forming a die. Dies so produced may be used for various purposes; embossing leather, stamping paper, or sheet metals, or for producing ornamental surfaces upon castings.

In the preparatory process of carbonising the delicate fabrics, leaves, grasses, etc., the objects are placed in a cast iron box, the bottom of which is covered with a layer of powdered charcoal, or other form of charcoal. Another layer of carbon dust is sprinkled over them, and the box is covered with a close-fitting lid. The box is next heated gradually in an oven to drive off moisture, and the temperature is slowly raised until the escape of blue smoke from under the lid ceases. The box is then raised to a white heat, and is so maintained for ten hours at least; after which it is removed, and allowed to cool. All foreign elements having by this treatment been eliminated, the articles become thoroughly carbonised, and are in a highly refractory condition. The most delicate fabrics may be subjected to the process without risk of destruction; and no special care is needed either in preparing the mould, or in pouring the metal. The mould is made in green sand, the fabric is laid smoothly on one face and held in position; and, as the metal flows into the mould, it presses the fabric against the sand wall, and takes the impression, which is as sharp as an electrotype.

Several illustrative examples are given with the paper, showing clear impressions of coarse and fine lace, and machine-embroidered dress goods.

THE "VALLEY" CUT-OFF GOVERNOR.

The Valley Ironworks, Williamsport, U.S.A., have improved their make of engine, which has already attained considerable notoriety, and the engraving herewith, for which and for the description we are indebted to the *American Engineer*, represents the governor as now made. The governor belongs to the class which draws the eccentric across the shaft, shortening its throw, and altering the travel of the valve, in this manner varying the point of cut-off to meet change of the load and steam pressure. It will be seen from the illustration that the outward movements of the levers are controlled by the centrifugal force of the weights on them, and this movement is (by the link shown) conveyed to the eccentric, which slides in a sleeve next to the hub. The centripetal force is obtained by the springs shown. Close examination of this system will reveal the following: That such an adjustment of the two forces can be obtained as will admit of close regulation, such length and size of springs, and such initial tension given, that the increasing or diminishing force of the weight due to the distance from centre of rotation is uniform with the increasing or diminishing force of the spring, due to its elongation or contraction; this construction admits of better regulation than where gravity or other constant force is employed. The governor can be reversed by turning the sleeve half round on the shaft, and pivoting the levers to run the other way.



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* Institute of Civil Engineers, Foreign Abstract.

FIVE-INCH GEOMETRIC LATHE.

CONSTRUCTED BY THE LONDON LATHE AND TOOL COMPANY, 37, POMEROY STREET, E.C.

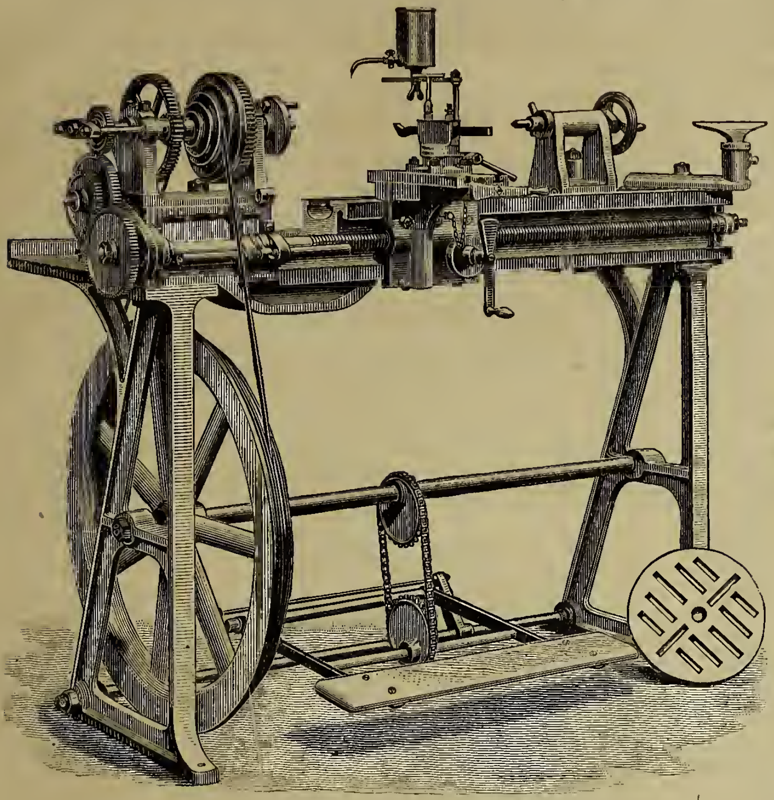


Fig. 1

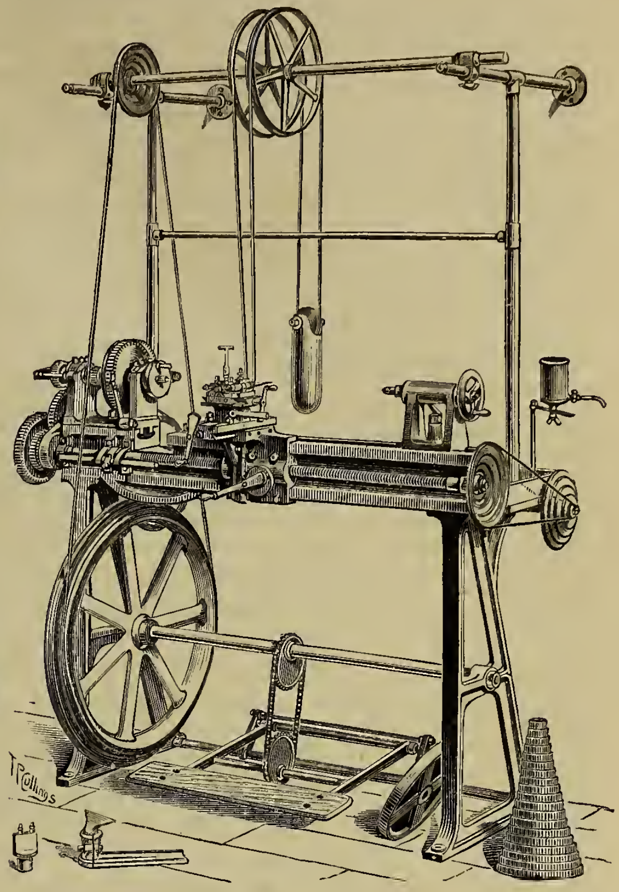


Fig. 2.

The front slide lathe constructed by the London Lathe and Tool Co., 37, Pomeroy-street, S.E., shown in the two figures annexed, is so much of a novelty as to merit a notice in these pages. The two features which are most apparent in the engravings are the mode of driving, and the construction of the slide rest. The usual driving cranks are dispensed with, and eccentric sheaves substituted, the object being to obtain a longer or shorter throw, varying with the heavy or light character of the work on hand. To produce this variation the spindle of the lower sheave swivels loosely in its bearings in the treadle frame, so that it can be turned through the whole or any portion of a circle to alter its position relatively to the one above. The alteration can be effected instantly on the disengagement of the pitch chain; but when the chain is placed and strained on its sprockets the relative positions of the wheels cannot change during driving, because the interlocking of the sprockets and the links effectually prevents slip.

The motion of the driving wheel can be communicated to the work either with or without the intervention of the back gear; but, since the lathe is designed for geometrical work as well as for ordinary turning, the front cogwheel, that is, the one which receives motion from the back gear, is made to do duty as a division plate also. Evidently the presence of the ordinary locking bolt and slot, by means of which the cone pulley and front wheel are commonly united, would interfere with the circles of holes for the division peg. Instead, therefore, of using the common bolt, the cone and wheel are clamped together for heavy work by means of a nut encircling the mandrel at back of cone which nut can be instantly tightened or slackened with a tommy. There are five circles of holes en the wheel face, numbering respectively 192, 180, 160, 120, and 100.

Communication between the headstock and saddle is made in two ways, either directly through the change wheels, or by means of a shaft which runs underneath the tool board at the back. The first is used for screw-cutting and heavy turning, the second for light turning only. In the first case a small four-jawed clutch at the left of the gap is placed in gear with a similar clutch on the left end of the leading screw, effecting a steady union between that end and the continuation of the same shaft just below the front of the headstock. In the second case, this clutch being thrown out of gear, the change wheels are inoperative, but the back-shaft drives in the way to be described directly.

The action of the clutch is controlled by the small rod to be seen in the figures. This rod slides in lugs standing out in front of the bed, and is itself embraced by the boss of a fork, the boss having a set-screw for pinching it in any position on the rod, and the fork embracing the body of the sliding clutch. When the clutch is in gear, the leading screw to the right, and its prolongation to the left, are driven together; when out of gear, the leading screw is either not driven at all, or is driven by means of the back-shaft. The latter is operated by a cord running over a single-speed pulley at the tail end of the headstock, and driving a larger and single-speed pulley on the left end of the back-shaft, which runs underneath the tool board. These are not shown in the figures. At the opposite, or right hand end of the shaft, a stepped pulley (seen in fig. 2) drives a similar stepped but reverse pulley on the leading screw. This last is tightened or slackened with a conical fitting, so that it need not run with the screw except when required. Thus it is easy to see that the lathe can be driven through back gear and change wheels, the clutch being in; or that by throwing out the clutch, light work can be done automatically by means of the back-shaft; also, the clutch being out, that the rest can be operated by hand alone, without in any way interfering with the wheels on the headstock. More than this, the clutch provides an automatic throw out, or safety stop, when cutting up screw threads, and when turning plain shouldered work, preventing the tool from travelling too far, and so doing injury. The set-screw on the boss of the fork being slackened, the small rod is slid along until it touches the saddle at that position where the action of the tool is required to be arrested, and there pinched. Whenever, therefore, the saddle arrives at that position in the process of screw cutting or turning, it thrusts against the rod, and so throws the clutch out of gear, causing instant stoppage of the saddle. The advantage of this simple and efficient arrangement will commend itself at once to those who operate screw cutting lathes.

To many the chief interest in this lathe will centre in its front slide rest, which is an embodiment of an idea long advocated by many amateur turners. One of its advantages is, that it can be slid along to the right hand of the poppet out of the way, in order to do plain hand turning with the Tee rest. Often in common lathes the L rest is used for this, but the arrangement is much more awkward and in the way than the hand rest and Tee. The other advantage claimed is, that there will be less abrasion of the wearing surfaces with a front slide than with the top saddle, between which and the bearers the chips and dust are apt to gain access. The objection to the front slide is a supposed lack of stability, due to its overhang. This is a question of fitting; actually we can say that no want of stability is perceptible, two well-fitting adjustable strips maintaining the saddle perfectly rigid against the thrust of the tool. The saddle is operated by means of the handle seen in front, which actuates a spiral wheel gearing into a second wheel encircling the nut of the leading screw. There being no rack traverse, this is also the only means by which the saddle can be run back in readiness for another cut. The action is very smooth, and the resistance so slight that the rest can be traversed rapidly, notwithstanding the number of revolutions required, one turn of the handle giving $\frac{1}{8}$in. of traverse. There is a divided circle on the front end of the saddle encircling the spindle, so that the traverse of $\frac{1}{200}$th of an inch can be read off. The surfacing slide is actuated by a screw of ten threads per inch, which, with its head divided into tenths of an inch, gives a reading to the $\frac{1}{100}$th of an inch. This capacity of minute adjustment, both for pitch and depthing of screws, renders the multiplication of parts of the ordinary compound rest superfluous. The tool holder in fig. 1, and the drilling spindle in fig. 2, are carried in a socket which is bolted to the Tee slots in the surfacing slide. This socket, and also the socket of the Tee rest itself, is clamped by means of a divided lug and pinching screw, which does not bruise the shank, and affords better security than the ordinary form of tightening screw. The poppet mandrel has a screw of ten threads per inch, hence a single turn of the handle moves it one-tenth of an inch. The mandrel body itself is marked with inches and eighths of an inch. The headstock mandrel is bored hollow for stud turning. The driving axle has a novel provision for lubrication, not shown in the figure. Hollow brass caps closely embrace each end of the axle, and extend a little way over the pivots. These therefore prevent the oil from being thrown off while driving, and retain it while the lathe is at rest, and thus avoid waste and dirty floors.

APPLIED MECHANICS.

ELEMENTARY STAGE.

8. Describe the hydraulic accumulator for storing up water under pressure. If the ram of the accumulator be 6in. in diameter, what load will be required to produce a water pressure of 500lb. on the square inch? To what head of water would this pressure correspond?

The hydraulic accumulator usually consists of a very strong cylinder fitted at one end with a gland and cup leather, and at the other with two pipes with suitable valves attached, which lead the water in and out. In this cylinder works a heavy solid plunger, which is additionally weighted by a box filled with scrap iron, or by a number of cast iron rings hung from it. The suspended weight is kept perpendicular by guides.

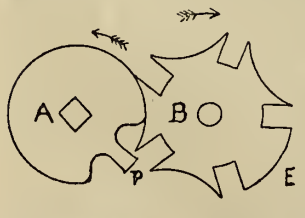
Area of ram $= 6 \times 6 \times {\cdot}7854 = 28{\cdot}274$ square inches.

$28{\cdot}274 \times 500 = 14137$lb. $= 6$ tons $6\frac{1}{5}$ cwt.

A head of water 34·56ft. in height gives a pressure of 15lb. per sq. in.; therefore the head of water corresponding to a pressure of 500lb. per sq. in. $= 500 \div 15 \times 34{\cdot}56 = 1152$ft.—Esse.

[Good answers from A. Coates, G. W. W., A. S. K., General, Y., etc.]

9. Describe, with a sketch, the Geneva stop, and explain its action.



The Geneva stop is a contrivance to prevent the spring that sets in motion a train of wheels from being over wound. The disc A, having a projecting tooth P, is fixed upon the axis of the barrel containing the spring; it is turned by the key that winds up the spring. A disc B is also fitted to the cover of the barrel, engaging with A. When A is rotated, the tooth P advances B through a certain angle each revolution, and will continue to do so until the convex surface E meets the convex surface of A, which prevents further rotation of A, when the winding ceases. The discs return to their normal position when the spring runs down.—G. W. W., Manchester.

[Good replies from Esse, Wass, Fryer, General, A. G. K., etc.]

ADVANCED STAGE.

28. Show, by a sketch, the combination of wheel work necessary for an eight-day clock, and give numbers to the wheels which would produce the motion required, pointing out the axis or arbor to which the minute hand is attached. How is the motion of the hour hand obtained?

Fig. 1 shows the arrangement of wheels to turn the minute hand. The weight W is attached to the axis of the great wheel T, which has 96 teeth, and turns round once in twelve hours. It engages with a pinion, S, of eight teeth. So S turns round once in an hour, and has the minute hand A attached to it. If the pendulum swings 60 times in a minute, the scape wheel D will then have 30 teeth, and turn once in a minute; so the value of the train from centre wheel R to scape wheel D must be 60. Let e = value of train = 60.

$$e = \frac{R \times M}{N \times C} = \frac{64 \times 60}{8 \times 8} = 60.$$

$\therefore$ R has 64, N 8, M 60, and C 8 teeth. As the clock goes eight days, the great wheel must turn round 16 times.

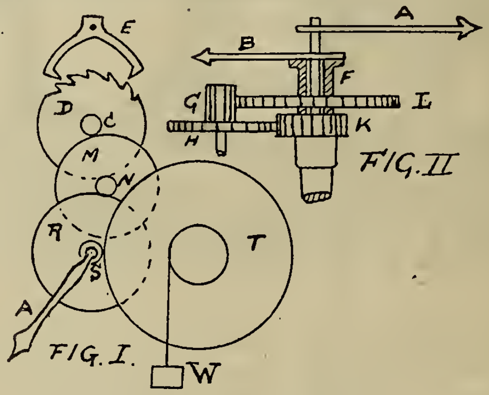


FIG. I.

FIG. II

Fig. 2 shows how the hour hand is driven by the minute hand. The pinion K is attached to the axis of the minute hand, which drives H. The motion passes through G to L, which is fastened to the pipe F, carrying the hour hand B. The value of this train $e = \frac{1}{12}$, as A makes twelve revolutions to one of B;

$$\therefore e = \frac{K \times G}{H \times L} = \frac{28 \times 8}{42 \times 64} = \frac{1}{12}$$

—G. W. W., Manchester.

[To be strictly correct, the teeth of the scape wheel should have been drawn pointing in the opposite direction.—Ed. *P. E.*]

CLEARING WATERWAYS OF VEGETATION.

An ingenious plan for keeping waterways clear of vegetation is in use on some of the French canals. The inventor of the scheme, a M. Rabault, uses a series of V-shaped scythes, each of which is attached by the point of the V to a chain, by which they are dragged along the bottom of the stream. Each leg of the V is about 4ft. 6in. long, and the weight of the whole scythe is about 50lb., which is sufficient to keep it down to its work. The chain is attached to a windlass on a boat, so that the arrangement can be raised whenever the scythes required to be re-sharpened, which is, generally, about every hour. The boat is drawn by a horse, but two towing ropes are used, one being attached to a point near the bow of the boat, and the other to a point at the stern. Each rope can be shortened independently of the other, by means of capstans fitted for this purpose, so that the angle the boat makes, with the resultant line of towage, can be varied at will, an arrangement which is said to be very useful in passing round curves. Two men and one horse only are required to work the apparatus, which costs about £120, and on a canal 33ft. broad, is capable of dealing with from 15 to 16 miles per day. In one case, in which this system has been introduced, the cost of keeping the channel free from vegetation has been reduced 60 per cent., whilst at the same time greater efficiency has been secured.—*Engineering.*

AN ENGINEER'S LIFE AT SEA.—I.

BY A SEA-GOING ENGINEER.

As the *Practical Engineer* is intended for various classes of readers, a description of life in the engine-room may be of some little use to intending sea-goers, and possibly may not be devoid of interest to those who have left the sea. If the subject, as here treated, should be of any assistance to the former, or of interest to the latter, my object will be gained. What I shall write is simply an account of one individual's experience, and hence any omissions are thus accounted for.

We will suppose a young engineer has applied for a berth, and that he has shown his certificate of indenture to prove that he has "served his time," the testimonials and letter of introduction, should he have one, have been found satisfactory, and that he is appointed third engineer, say on a Mediterranean steamer. The young man goes aboard with some little anxiety and curiosity as to the other engineers, but these soon put him at his ease. For the first few days there is plenty of work to be done, assisting in the general overhaul of the machinery, during which time it is advisable to get acquainted with the engines, for one finds in the course of experience that every engine has physical, and I had almost said mental, peculiarities of its own, for the whole world of machinery has been built up from the thoughts of many minds, and each particular engine, being the idea of its constructor, embodied in iron and brass, has many of his mental peculiarities.

The first and second engineer will probably be found willing to give our young man every information; but they will be quick to discover if his tongue is more active than his brain. It is the best policy never to ask a question unless you cannot get the information in any other way. The firemen as well as the engineers, it should be said, are observant, and quickly note if the new recruit's intelligence equals his skill as a workman, and if he is an engineer as well as a mechanic.

By the time the day of sailing comes round a fairly good knowledge of the various pumps, with their levers and rods, their valves and cocks, etc., will have been obtained, and once at sea these details will soon become well known. On the day before starting the engines are closed up, water run into the boilers, and the fires laid, ready to be lit about four hours before the time fixed by the captain for starting. About an hour before leaving dock, the second engineer takes our third below, and they proceed to open the discharge and feed valves, and to remove the turning gear. This is a most important matter, and if neglected will lead to burst pipes and a turning wheel stripped of teeth, or a broken worm on the turning screw. Then the oil boxes are filled, and the cotton syphons made ready to be put in. By this time steam is up, and the stop valve must be opened a little, and the engines "blown through" with drain pipes open. It may be noticed that the "second" does not blow more steam through the low pressure cylinder than he can help, so as not to overheat the condenser. If a circulating donkey pump is at work, this heating is not so likely to occur, but is always to be avoided. Our "third" is now sent on deck to tell the officer in charge that everything is ready to take a turn out of the engines, and also to see if the propeller is clear of ropes, chains, or boats. After reporting all clear, a final look round the engines is taken, to see that no blocks of wood, or hammers or chisels used in the overhauling, are left to foul the pumps or crossheads in their stroke, and the "third" takes his place at the starting wheel, which he has been shown how to work, the "second" meanwhile being at the steam handles. If the engines have not been properly warmed through, they will make most dismal and awful groans on starting, and will make the ship quiver, but with proper management this should not occur. "Put her ahead," and round spins the starting wheel, while the polished quadrants and eccentric rods come sliding over; a touch of the handles by the "second," and the engines stir, pull themselves together and are off. "Stop and reverse her," and the ponderous cranks come to a stand for a moment, and then revolve in the opposite direction; only two or three turns each way can be taken, as the vessel is fast to the dock wall, and strong ropes would break like thread if the engines were allowed to work much. Everything now being in readiness, the "third" returns to the deck and keeps a sharp look out on the preparations for leaving, so as to know when the engines will really be wanted. When he sees that the pilot and captain mean business, he descends once more to his post at the starting wheel; the firemen are told to open their dampers and freshen up their fires, so that steam may not fail when the engines begin to draw on the supply, and he must also watch that the firemen do not allow their steam to rise so as to roar up the waste pipe. Now the "stand by" rings, and the engineers are alert and the engines ready.

All this time the chief engineer keeps in the background, but he is not far off, and is ready to assist the "third" in a moment if required. Upon him rests the responsibility of all, but he leaves the new hand as much as possible to himself, that the latter may gain confidence.

At the last moment the "third" is warned to be quick with his starting gear, for the vessel is surrounded by shipping, and the least delay in obeying the telegraph may cause serious damage to his own ship, or to others, or to the dock wall. A loud blow on the gong and the pointer is at "slow ahead," but scarcely have the engines moved than the order to stop and reverse, and stop again, are received, and for the next hour he has a busy time of it with his wheel. During all this time the noisy clatter is heard of the winches on deck, which, like more intelligent creatures, often make the most noise when doing the least work; when putting forth their strength one hardly hears them, but when pulling in loose ends of rope there is no silencing their rattle. The tramp of the sailors above and the words of command, are also plainly heard; in the stoke hole is the ring of the firing tools; and in the engine-room the muffled beat of the engines, with the occasional noisy rush of steam through the opened drain pipes of the cylinders. At last the word is passed down that the vessel is out of dock, and while the engines settle down steadily to their work, the "third" is allowed to go on deck to "have a blow." The steamer is now gliding down the river, which is alive with shipping, for it is full tide, and crafts of all sizes are taking advantage of it. Presently the "third" is sent below again, for the pilot is leaving, and the engines must stop. When he has gone the welcome order is given of "full speed ahead," and the vessel is fairly off on her voyage.

FUTURE OF INDIAN PETROLEUM.

We hear, says *Indian Engineering*, that Mr. Townsend, the petroleum expert, has succeeded in obtaining a supply of 300 barrels of oil daily from each of the two wells at Khatun, and that this field is likely to yield a large permanent supply, but we should like to know what probability there is of India supplying her own wants from local sources. The imports of Batoum oil are on the increase, and may be expected, in the course of time, to supplant those of American oil, though, at present, the latter carries the palm for quality. What is desired, however, is for us to render ourselves independent of imported oil from Russia or America, and to develope our natural resources to the fullest extent. The trial borings made warrant the expectation that these resources are of considerable extent, and we should like to see some practical steps taken towards placing the matter on a commercial footing. We learn from Burmah that some of the small companies are doing very well, and making good profits, a Mr. Savage, who is working in the Boronga fields of the Akyab districts, upon a small concession granted to him by the local Government, being reported to be achieving a splendid success.

THREADING THE HOCKLEY TRAMWAY CABLE.

On the last day of the old year the difficult task of threading the cable of the Hockley cable tramway, Birmingham, was undertaken. Work was commenced at 11 o'clock on the Saturday, and, by a quarter to nine next morning, the operation had been completed, and the two ends of the cable were temporarily spliced together. The cable was wound on a single reel, and to one end was attached 50 yards of thinner cable, which it was at first intended to draw along as slack by two horses, while two bogies 50 yards apart, moved by locomotives, dragged the main cable. This arrangement was, however, found impracticable, as the splice between the thick and thin cables doubled in advance and caught against the pulleys. It was therefore decided to cut this splice away and trust to the bogies alone, after which another start was made. It was then found, however, that the two bogies could not be kept at the same speed, and, the second gaining on the other, commenced to double the cable in its chamber. The locomotives were therefore removed from the second bogie, all the pulling being done by the one in front. This arrangement proved successful, but the progress made was somewhat slow, as signals to stop were frequently flashed by lantern from the paying-out station owing to hitches occurring there. The line has been designed by Mr. E. Pritchard, M.I.C.E., of 37, Waterloo-street, Birmingham, and Mr. Kincaid, M.I.C.E., of London.

THE ELECTRICAL DISTRIBUTION OF TIME

In a paper recently read before the Paris Académie des Sciences, M. Cornu has shown analytically that to obtain synchronism in a vibrating system, the necessary and sufficient condition is that the free motion of the system shall be a damped vibration, and has also pointed out that the stable condition is obtained more rapidly the greater the amount of the damping. To carry out this in practice, it is necessary, if two pendulums are to vibrate synchronously, that they should experience an impulse in one direction, and a retardation in the opposite sense in rigorously the same way. This M. Cornu obtains by fixing a permanent magnet to the lower extremity of the pendulum. An electro-magnet, with an open circuit, is fixed on one side of the pendulum, and attracts it at each oscillation. On the other side is placed another electro-magnet, with a closed circuit, which acts simply as a damper, and checks each swing. In this way perfect synchronism can be obtained between clocks a very considerable distance apart, which, indeed, is only limited by the length of line at which the retardation of the current from self-induction becomes sensible. Clocks constructed on this principle for the Geographical Department of the French War Office have been successfully synchronised over a distance of forty miles of a defective telegraph line.—*Engineering.*

CORRESPONDENCE.

We do not hold ourselves responsible for the opinions of our Correspondents.

EVAPORATIVE EFFICIENCY OF VERTICAL AND EGG-END BOILERS.

To the Editor of "The Practical Engineer."

SIR,—If your correspondent "M.E." will communicate direct with me, I shall be pleased to give him sketch and full particulars of an horizontal boiler that would answer his purpose, and would not occupy more space than he names, viz., 12ft. by 4ft. 6in.—Yours obediently, THOS. BADGER.

48, Upper East Smithfield, London. E.

THE BOILER REGISTRY BILL.

To the Editor of "The Practical Engineer."

SIR,—The Oldham Chamber of Commerce, at its meeting in December, had the above subject before them for discussion, and some few remarks that fell are perhaps worth notice. The question had been left over at a previous meeting for the consideration of a committee, one member of which was an engineer of repute, and he naturally expressed regret at the lack of interest taken in the Bill, as each and every member of the Chamber was affected thereby. He proposed a very sensible resolution, approving of compulsory inspection by qualified and disinterested persons of the district rather than by the centralised authority in London. The chairman immediately offered a strong opposition to the Bill in any form, remarking that he considered it absolutely unnecessary, and small mechanics, blacksmiths, and farmers would be prevented from using steam altogether. This is difficult to accept, seeing that the owner would only be called upon to do what is now in many cases being done voluntarily, that is, to pay a subscription for inspection. How he arrives at the opinion that engine tenters and stokers will, by virtue of the Bill, resolve themselves into a "vast trade union," and who will, in accordance with the provisions of the Bill, "have to be examined," and their wages advanced and paid for as "skilled labour" I cannot conceive, as the Bill makes no such provision. I think your readers generally will admit that there is little fear of inspectors "ordering walls to be pulled down," as the chairman here suggested. In speaking of the "amount of accidents," he either ignores or forgets the facts that the Bill is not to remedy accidents at all. The too lenient bearing of those who have had the working of the Act of 1882, appears to have satisfied two of the gentlemen, one of whom made the alarming statement that by the Board of Trade rules, the whole of the boilers now in use would have to be taken out, and therefore moved the following amendment, "That the Oldham Chamber of Commerce most strenuously opposes the Boiler Registry and Inspection Bill, 1887, which it considers unnecessary, as shown by the rapid diminution of accidents, etc., etc." Where is the rapid diminution? I cannot find it. The remarks of the seconder of the amendment were ill-chosen indeed. In comparing boilers to dogs, and explosions to hydrophobia, he apparently forgets that every dog must be licensed and paid for, or its owner liable to a penalty, and also forgets that if a dog is said to be dangerous it must be destroyed. In any case the comparison is a most unfair one. During the 21 years ending December, 1885, there have been 1,221 lives lost by explosions in this country alone. Have there been half so many deaths from hydrophobia, and do not dogs outnumber boilers by more than ten to one? The same gentleman has thought fit to fix a certain value on life. I should like to know if there is any difference in the value of his own and his fireman's life; if so, what? How another gentleman could make the matter political I fail to see, as it cannot be said to be "class legislation" any more than "Hugh Mason's Bill of 1882." One gentleman, however, had the courage to vote against the amendment, so that after all, it was not an unanimous vote. Any of your readers who have followed the explosion reports cannot fail to be impressed with the idea that the Board of Trade appear to have made up their minds to have charge of all land boilers sooner or later; and from the manner in which the explosions have been enquired into, they have made out a strong case for themselves, and I believe if this Bill is frustrated, it will shortly be followed by one even more stringent.—I am, Sir, yours truly, A FOREMAN.

January 6th.

TESTS OF BOILER STEEL.

To the Editor of "The Practical Engineer."

SIR,—In your issue of to-day, I am pleased to find an item of news which will give your readers pleasure, and for which they will no doubt be thankful. Speaking personally, and as having made the suggestion myself, I hasten to offer you my thanks for another instalment of practical benefit for which I might have looked in vain in the so-called high class engineering papers. We now have a guarantee that in dishing plates under the hydraulic press there would appear to be an uniform flow as it were of the material, and not a local thinning of the parts subject to the most severe pressing; we also know now that the tensile strength is not impaired. This must certainly be valuable information to boiler makers, and I feel sure that it is now only a question of time, and money for new and suitable tools, and we shall have hemispherical ends for boilers even up to 8ft. diameter, in which case much of the present cumbersome heavy staying can be dispensed with; and then a marine boiler built with the Whitworth solid ring of plates, and solid hemispherical ends, might be made 40 per cent. lighter than at present. If hemispheres can be made to a radius of 2ft. from $\frac{3}{16}$in. plates. I feel sure they can be made from $\frac{5}{8}$in. plates to a radius of 4ft. You suggest that a comparison of strength before and after would be interesting, but as we cannot get it, we must be satisfied with the test given, which is of course the most important. I have seen many plates tested during late years, and just give a few averages to show there cannot have been much loss in the case in point.

Thickness.	Area.	Tons per square inch.	Elongation in 10in.	Per cent.
$\frac{3}{8}$in. full	·76	28·7	$2\frac{3}{8}$in.	23·7
$\frac{17}{32}$in.	1·03	28·5	$2\frac{5}{8}$in.	26·2
$\frac{9}{16}$in.	1·12	27·1	$2\frac{5}{8}$in,	26·2
$\frac{1}{2}$in.	1·00	28·3	3in.	30·0
$\frac{1}{2}$in.	1·00	28·9	$2\frac{5}{8}$in.	26·2
$\frac{1}{2}$ full	1·05	28·5	$2\frac{3}{4}$in.	27·5
$\frac{1}{2}$ bare	·99	28·0	$2\frac{5}{8}$in.	26·2

—Yours, etc., KIER.

Jan. 6th, 1888.

P.S.—These are plates by three of the most noted makers, and are not specially selected, but fair averages; all were tested less than six months ago.

GRAPHIC REPRESENTATION.

To the Editor of "The Practical Engineer."

SIR,—No doubt many of your readers besides myself were pleased to see "Graphic's" letter in your issue of 30th December, setting forth the advantages of the graphic method of solving problems. It is certainly true that the adoption of this method often saves much time and labour, besides obviating to some extent the liability to error. The loaded governor question taken by "Graphic" is a good example, as the calculations involved are somewhat troublesome.

There are two points, however, in the solution given which do not appear to be correct, and to which I wish to draw your attention Your correspondent states that "A Molecule" has taken the centre load to be 72lb.; this is not so, it being only 36lb. as stated in the original question solved by "A Molecule." It should be borne in mind that with equal links, the vertical rise of the centre load is double that of either ball, so that the ratio of the height of the cone to that of the ordinary pendulum governor is as $(2P + 2W) : 2P$, that is $(1 + \frac{W}{P}) : 1$. Also in the expression given for centrifugal force "mass in lbs." is evidently used instead of "weight in lbs;" if not, the divisor "g" = 32 must be omitted.—Yours, etc.,

7th January, 1888. Lindum.

QUERIES AND REPLIES.

Copper Balls.—Could any reader oblige with information as to how the halves of copper balls (similar to those used for water ball-valves) are made. Is the copper pressed to shape between top and bottom dies, or is it spun or gradually worked into a corresponding half-mould, in a lathe or similar machine? I want to make some about 3in. diameter.—Sphere.

Signalling.—Will any reader give me the most approved method of signalling in long and steep inclines, and the advantages over the old wire and hammer system.—W.A.

Hopkinson's Safety Valve.—Could any reader give me a description of Hopkinson's dead weight safety valve, and show how to calculate the weight for different pressures. A sketch will oblige.—S.S.N.

Launch.—Could you or any of your readers inform me as to the thickness of steel plating used in the construction of a launch; the usual length and breadth of same, sizes of Frames, also the best method of constructing the kiel.—W.B.

Launch Building.—Will some reader inform an amateur as to the best method of making the lap joints of small steel launches watertight, also as to the best anti-corrosive paint, as the plates, $\frac{1}{16}$in. thick, are not to be galvanised. Is there any book published on launch building, giving details, &c,—(Scantlings), J-D.

Dies for Shoe Rivets.—Could any reader inform me how the dies used for putting the screw-like marks on shoe rivets are sunk. Any information on this matter would greatly oblige—E.B.

Electrical Resistance.—What is the simplest apparatus for measuring the electrical resistance of a metal or a liquid?—J.D.

The Odontograph.—What work contains the best practical description of the odontograph?—J.E.H.

Enamelling Iron.—Can any of your readers give me the names of firms who enamel small iron or steel articles, such as guide bars and mouse-traps used in silk machinery.—Kiel.

TO CORRESPONDENTS.

Kiel,—Edie Bros., Victoria Buildings, Manchester.

A.R.—We do not know of any book on the subject.

G.E.P.—*La Revue Industrielle* would suit you perhaps better than any other.

Ram.—You must get the size of low pressure cylinder, first allowing for a terminal pressure of about 10lb. absolute, or 5lb. below atmosphere. The size of small cylinder can easily be decided afterwards by adopting a proportion of say 3 or 3½ to 1.

An Enquirer—The strain (stress) on the fulcrum of a steel yard is always equal to the weight of the machine itself, together with the object being weighed; this applies to any machine, no matter what the length of the arm may be. You will, of course, know that when the sliding weight stands at zero the beam should be in exact balance, and the stress on the fulcrum is equal to the weight of the machine. Any load that is now put on simply increases the stress on the fulcrum by the weight added and no more.

R. M.—When the nut N is loosed the hand-wheel W may be revolved without turning the worm wheel, and on the other hand, when the wing nut is screwed up again the worm wheel and hand wheel are wedged together and made practically into one. The large wheel N is threaded on the screw F, and so the latter is raised and lowered when the feed motion is revolved. The kind of joint at O can be seen on any drill spindle in a workshop.

H.T.—The usual formula for strength of a round shaft is $\frac{d^3fs}{5{\cdot}1}$ which is simply a reduction of $\frac{\pi d^3fs}{16}$ and is therefore equal to $Asfs\,\frac{r}{2}$ where r is the radius and the other letters are as given in your communication. The strength of the key is $Akfk$, and therefore for equality we must have $\frac{Ak}{As} = \frac{r}{2}\,\frac{fs}{fk}$

MISCELLANEA.

M. Lesseps.—M. de Lesseps will pay another visit to Panama in March to inspect the progress of the canal works.

Electric Lighting in Kansas.—It is said that every town in Kansas that has a population of 3,000 and upwards is lighted by the electric light.

Electric Light in Theatres.—The municipal authorities at Madrid have decided to close all the theatres of the town which are not lighted with electricity.

Removal of Office.—The Bolton Steel and Iron Company have moved their London office to 38, Parliament-street, Westminster, S.W. Mr. Thomas Marlow will conduct the business.

Civil and Mechanical Engineers' Society.—The next meeting will be held at the Town Hall, Westminster, Wednesday. the 18th inst., at seven p.m.. when a paper on "Steel Sleepers," by Mr. H. T. Munday, H.M.I.C.E., will be read and discussed.

The Manchester Exhibition.—The accounts of the Executive Committee will, we believe, very shortly be made up, and when duly audited they will be submitted to the guarantors. The net surplus will, it is understood, be little short of £50,000.

Mischievous Cable Slot.—The slot of the cable road at St. Paul, Minn., is said to be playing the mischief with horses. It is so wide that the calks of horses' shoes are readily caught in it. with the result, if the horses are on a trot of throwing them and sometimes breaking their legs or tearing off their hoofs.

Removing Rust.—Steel or iron, it is said, can be freed from rust, regaining its original polish, by the following method: Mix 15 parts prussiate of potash, 15 parts fat soap, 30 parts chalk with water to a thick paste. Damp first the rusty portions with a solution of prussiate of potash in double its weight of water, and then rub the spots with the above mixture.

Holding Small Articles of Iron.—An ingenious plan for holding small articles of iron or steel, which is too difficult to fix in a vice, has just been patented in America. The plan consists in fixing on the workman's bench a powerful electro-magnet, which it is stated holds small articles of iron or steel sufficiently firmly for filing, scraping, etc., to be performed on them.

English Holdings in American Railways.—American railway securities were quoted in the official list of the London Stock Exchange to the amount of £449,137,835. This was considerably over one-fourth of the whole railway capital of the United States, and was much more than half the capital represented by the railways of the United Kingdom. The greater portion of this amount is held by English capitalists.

New Railway Route.—A great event in the history of North American railway enterprise has just taken place. A train of cars laden with flour for Boston passed through Canada from Michigan. The Canadian Pacific line is now connected with the Michigan lines at Sault St. Marie, and the new through route is now said to be the shortest that exists between the Upper Mississippi River and New England, and therefore Great Britain.

Mileage Railway Tickets.—German railways have introduced a mileage ticket system. They are issued in little books, each leaf good for 5, 10, 50 or 100 kilos of travel. The gain by purchasing them is 25 per cent. for 1,000 kilos, 33 per cent. for 2,000 kilos, and 50 per cent., or half fare, for 5,000 kilos, or 3,100 miles. The holder of this book of coupons is identified by a photograph pasted upon the book, and by his signature.

The Eiffel Tower.—The 1,000ft. tower in connection with the French Exhibition of 1889, and known by the name of the designer and constructor as Eiffel's tower, has now reached the height of 179ft. The four arches of the base are now joined, and the great platform for the rooms of the first stage is about to be constructed, so that the work has past the most laborious stage. Most of the construction will now proceed from the interior.

Advantage of Forced Draught.—The advantage of forced draught and triple expansion is shown in the city of Paris and City of New York, two steamers now being built for the Inman line. These vessels will be 525ft. long. and 62ft. beam, or about 25ft. longer and 5ft. wider than the Etruria and Umbria. The grate surface in the new boats will be actually less than in the Etruria, although the power developed will be 50 per cent. more. The H-P. of the engine will be 18,000.

Progress on the Forth Bridge.—During the past month about 610 tons of material have been drilled, 960 tons erected, and 1,110 tons riveted. About 48,170 tons of steel have been delivered up to date, and of this amount 24,660 tons have been erected. The difficulties of erecting the four projecting parts of the bridge are not expected to be any greater than those already ecountered, and fears of danger from gales are not entertained by the engineers. The number of men employed is 3,180. The bridge has been visited during the year by an enormous number of people from all parts of the world.

Congress and the Telegraph.—The American Congress is so well pleased with its success in railroad regulation that many members are disposed to extend the same kindly supervision to telegraph companies. Three plans have been proposed:—1. To buy up existing lines and give the Post Office Department a monopoly of the telegraph service. 2. To build new lines to be run by the government independently, and in competition with the old ones. 3. To leave the ownership and operation of the lines in the same hands as at present, but to subject the companies to a system of regulation like that of the Interstate Commerce Act.

Amalgamated Society of Engineers.—The London executive of the Amalgamated Society of Engineers have expelled from their society four leading officials of the Bolton branches for having settled the recent dispute in the iron trade of that town without their (the London executive's) sanction. The expelled officials are Councillor Hough, chairman of the Bolton joint committee, Mr. Richard Barlow, the secretary, and Messrs. Bain and Thornton, committeemen. These gentlemen agreed, without the sanction of the central executive, to accept the employers' offer to submit the dispute, which had then lasted over six months, to arbitration. An appeal will be lodged against the decision.

English Locomotives for America.—An express passenger compound locomotive on Webb's system is now being built by Beyer, Peacock and Co., Manchester, for the Pennsylvania State Railroad. It will be precisely similar to the compound engines now running the mainline trains on the London and North-Western. The two high pressure cylinders, 14in. by 24in., are outside connected and actuate the hind drivers, while the single low pressure cylinder is 30in. diameter, and 24in. stroke, and is inside connected to the main drivers. The two pairs of drivers are not coupled and are 75in. diameter. The boiler pressure is 175lb. per square inch. This locomotive is intended for experiment, in order to compare with the best American locomotives.

Cheap Inland Transit.—A vigorous effort is being made to secure cheap and easy transit from Sheffield to the sea coast, and that a plan is now being formulated for that purpose, under more encouraging auspices than in former years. It is the decided opinion of many competent authorities in trade manufactures, that unless a canal connects Sheffield with Goole, or some other accessible port, the other heavy industries—such as tires, axles, springs, etc.—will follow steel rails, and leave the inland towns. Though ship-plates are still made here to some extent, the business has attenuated to a comparatively trifling amount, and one large firm has entirely given it up, finding themselves too heavily handicapped by the establishments situated on the coast.

Another Hoax.—A new candidate for favour in the steam-engine line, says *The Locomotive*, is a four-cylinder affair that exhausts back into the boiler, or is said to do so. The saving is to be 50 per cent. of floor-space, and 75 per cent. of fuel. There are "no valves. eccentrics, steam-chests, cut-offs, link motion, etc., to get out of order," and it has various other advantages, but as they do not save more than a paltry 25 to 30 per cent. of anything, they are hardly worth enumerating. The above claims look like absurdities, but as a drawing has been exhibited to the Chamber of Commerce in one city, and is to be exhibited on the New York Stock Exchange, and a company has been formed with a capital of 500,000 dols., we are forced to believe that—the gullible had better look out for their money.

Peculiar Action of the Electric Light.—A recent number of the *Journal des Debats* contains an account of the peculiar effects of the electric light at Creuzot, used to melt and solder metals. The electric arc in which the metals to be fused and soldered are placed, is of marvellous radiance, its luminosity on a few square inches exceeding 100,000 candles. Spectators at a distance of 10 yards feel no heat whatever from the arc, but they soon become conscious of acute pain and other symptoms similar to the effects of sunstroke. The effect is very singular, and points to the active part played by light in a variety of biological phenomena. Without any heat whatever all the effects of sunstroke are produced. Whether the skin is affected by the red and yellow rays, or by the violet and purple, is a question that might easily be settled by experiment.

SELECTED PATENTS.

APPLICATIONS FOR LETTERS PATENTS.

December 30th.

17,906 Corkscrews, J. Pluck, London.
17,909 Treating Residues from Galvanising Works, M. d'Andria. Liverpool.
17,912 Force Pumps, E. Prunier, London.
17,915 Propelling Ships, W. Fairweather, Manchester
17,916 Ironing Machines, H. C. Longsdon, Keighley.
17,917 Float Cocks, J. Shanks and R. Burnside, Glasgow.
17,918 Shaping Machines, G. Richards, Broadheath, near Manchester.
17,920 Construction of Wheels. G. W. Moon, London.
17,922 Tap and Pipe Connector, T. Fisk, Ipswich.
17,923 Locomotive, J. W. Smith, London.
17,926 Electric Safety Fuse, W. E. Hayne, London.
17,929 Ventilating, Refrigerating, and Heating, H. Carter and T. A. Carter, Bristol.
17 931 Syphon Tap, T. Jackson, Chiswick:
17,932 Railway Buffers. F. B. Stanton, London.
17,933 Gulley Trap, R. Garner, Birmingham.
17,934 Water-Gauge, F. A. Drummond, Ottawa, Canada.
17,936 Hot Air Stoves, C. Pottier, London.
17,937 Regenerative Lamps, A. Altman, London.
17,939 Rotary Brushing Machines, R. B. Hawkins, London.
17,940 Burners for Petroleum Lamps, F. J. B. Allen, London
17,954 Cranes and Hoists, J. S. Worth, London

December 31st

17,961 Horizontal Beam Compasses, M. C. Williams, Carlisle.
17,962 Measuring Indicator Diagrams, W. Bagshaw, Batley.
17,963 Pressure Cylinders and Valves, D Purves, London.
17,966 Miners' Safety Lamps, O. Y, Rhodes, Halifax.
17,968 Exhausting Cowl and Ventilator, W. Wilson, Newcastle-on-Tyne.
17,976 Safety Saddle Bars, A. Vickery, London.
17,985 Heating Water for Swimming Baths, J. Keith, Glasgow
17,990 Liquid Hydrocarbon Engines, T. C. Hogg, London.
17,992 Calipers, G. Howarth, London
17,993 Ventilating Cowls. J. Winterflood, London.
18,000 Governors for Marine Engines, J. Murrie, Glasgow.
18,011 Castors, F. Beauchamp, Middlesex
18,018 Surface Condenser for Steam Engines. A. Burckhardt and F. J. Weiss London.
18,020 Pipe Coupling, J- Thornton, London.
18,023 Boiler Tube, B. E. Hipkins, London.
18,029 Boring and Tunnelling Rock, J. A. McKean.

January 2nd, 1888.

7 Railway Chair, J. Hanson, Hovland Nether
10 Slide-Valve, J. Hargreaves, and R. H. Carr, Hunslet, Leeds,
11 Counter Thrust Engines, A, N. Porteous, Edinburgh.
12 Engines, B. W. Spittle and J, Sanders, Wednesbury.
15 Templates, M. C Williams, Carlisle.
16 Coupling for Propeller Shafts, B. Willcox, London. (La Société des Usines Franco Russes, Erance.)
17 Packing for Pump Piston, E. M. Eckardt. London
18 Bearings for Travelling Cranes, W. Craven, of the firm of Craven Brothers (Limited), London.
19 Compound Steel Plates, Carl Maria Pielsticker, London. (Major J. S. Williamson, United States).
21 Removing Scale from Steam Generators, A. G. Evans, London. H A. Livock, Argentine Republic).
25 Double Ventilator, I. Edelboum, Whitechapel.
29 Slow Combustion Stoves, J. H. Barnard, London.
30 Adjustible Regulators for Steam Boilers, A. V, Bay, London
36 Bar Iron, R R. Gubbins, London.
40 Electrical Block Indicators for Railways, E. Tyer, London.
51 Pistons, P. W. Willans, Thames Ditton.
53 Steam Engines, J. P. Lea, Luton.
54 Rotary Engines, A. L. A. Chouliac.

January 3rd.

60 Railway Ties, W. P. Hall, London.
61 Spring Safety Hooks for Couplings, J. Gregory and F. Gilport, Ennerdale, Birmingham.
67 Registering Weighing Machine, W. E. Richardson, Sheffield.
68 Corve Wheels and Axles, T. Rowbotham, Stockport,
69 Lubricating Corve Wheels and Pedestals, T. Rowbotham, Stockport.
79 Ball-Valve, J. I. Fairweather, London.
85 Mining Tools, J. Wilkes, London,
98 Rails, Sleepers and Chairs, H. H. Lake, London. (R. T. White United States.)
106 Brakes, H. H. Lake, London. (Ferdinand Eugène Schauffler and Amand Bayon, France.)

January 4th.

113 Sight-feed Lubricators, G. F. London and J. T. Stuart Glasgow.
116 A Mechanical Trap, T. R. Weston, London
117 Rotary Engines, D. Williamson, Manchester,
118 Smoke Consumer and Super-heater, S. Brooks, Huddersfield.
122 Lock-nut, C. Carus-Wilson and J. C. Bayley, Bournemouth.
126 Gas Governors, H. W. Cole and A. F. Cole, Stourport.
128 Steam Boilers, D. Adamson, Manchester.
132 Mechanical Excavator, J. J. Robins, Derby.
139 Drill and Ratchet.brace Combined, J. M. Wardle, Edinburgh.
142 Wheels and Pulleys, A. M. Brown, Hitchin,
145 Block Fuel, H. G. Radford, London.
147 Friction Clutches and Hoists, O. Flohe, London,

January 5th.

183 Interlocking Apparatus for Railway Points, J. Saxby, J. S. Farmer, and H. Reid
190 Slide Valves and Reversing Gear, C. E. Hall, Sheffield.
191 Smelting and Refining Furnaces, J. M. Bennett, Glasgow.
192 Varying Pressure in Hydraulic Cylinders, H. Berry, Hunslet.
203 Belt Fastener, H. Gittus, Manchester.
212 Lubricators, P. G. Pasquet, London.
218 Hooks for Cranes, W. H. Vaughan and T. Foster.
221 Piston Packings, F. F. Bourdil, London.
222 Fret-cutting Machine, J. Mackenzie and W. Armstrong.

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EDITORIAL NOTICES.

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Communications intended for insertion in the current week's issue should reach us not later than Tuesday Evening.

We cannot undertake to return rejected manuscripts or drawings unless accompanied by a stamped and directed envelope.

Contributors are requested to write on one side only of the paper. Sketches should be sent on separate sheets.

TO ADVERTISERS.

Advertisements intended for insertion in the current issue should reach us on Wednesday morning at the latest.

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NOTICE TO NEWSAGENTS AND SUBSCRIBERS.

Numerous complaints having been made to us by Subscribers of the difficulty they experience in obtaining copies of the *Practical Engineer* in certain districts, we have to state that the Journal can be obtained by any Newsagent through the ordinary Trade channels, and no difficulty should therefore exist in obtaining copies by order of any Newsagent.

For the information of the Trade, we may state that copies can be obtained from either of our Offices in London or Manchester, or from any of the following wholesale houses, who are also supplied with Contents Bills for the use of the Trade:—

W. H. SMITH & SON, Strand, London.
W. H. SMITH & SON, Blackfriars Street, Manchester.
JOHN HEYWOOD, Deansgate, Manchester
ABEL HEYWOOD & SON, Oldham Street, Manchester.
J. MENZIES & Co., Hanover Street, Edinburgh.
J. MENZIES, & CO., Drury Street, Glasgow.
W. LOVE, 236, Argyle Street, Glasgow.
W. H. CLOUGH, Well Street, Bradford, Yorks,
JOHN MORGAN, Wholesale Newsagent, Bradford, Yorks
A. G. BEACON, Pershore Street, Birmingham.
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EDWARD KING, 37, Greyfriars Lane, Coventry,
W. THOMPSON & SONS, St. Petersgate, Stockport.
&c., &c., &c.

ATTENTION TO SMALL MATTERS.

In engineering, as in every other profession, attention to detail is a very important matter. Defects, however serious, in a machine or structure, have had usually a small beginning, when a little care on the part of the attendant might have put things right again at a very trifling expense. A machine, engine, or boiler, must have careful supervision and attention to the moving parts especially if they are to last well and not require constant repair. As an instance we may cite journal bearings, which, if kept well lubricated and clean, seldom require taking up, and renewals are few and far between; whereas, if grit is allowed to get in, or the bearings to run dry, hot necks result with immediate calls for repairs. Misfortunes of this kind are certainly not so common now as they were a few years ago, as almost all bearings are made on the swivel plan, and fitted with pin or other form of continuous lubricators, but still even these should be looked at occasionally, or they will be sure to get out of order with mischievous consequences. Leakages in boilers are of common occurrence and are, perhaps, the most prolific cause of deterioration necessitating repairs, yet a small leak is passed over as of no consequence whatever until, perhaps, damage enough is done to demand instant attention. Only this week we noticed a leakage at the joint of the feed pipe with the front end plate of a small Cornish boiler, which had been allowed to go on unchecked for weeks and months; the incrustation formed on the plate, one would have thought was unsightly enough to force the attendant to see to its prevention, without any consideration of damage to the plate, but it had not been enough in this case, and we expect the leakage will be allowed to proceed until the plate becomes dangerously weakened and imperatively calls for repair. A very common defect in the arrangement of steam boilers is to fix the firing floor or foot plate at such a level as to conceal a portion of the front end plate; nothing is more provocative of corrosion in the plate than this, as there are almost always ashes lying about, and it is very difficult to keep them dry. A much more sensible arrangement is to place the firing floor plate below the front end plate, so that the latter may all be seen and kept free from damp ashes. It would be easy to name scores of similar details about the construction and management of engines and boilers, all of which are apparently of slight importance, but really lead to serious consequences or frequent annoyances, and therefore would do well to be attended to from the very beginning. Gearing, belts, engine pistons, are instances of the parts that are often neglected, and from want of constant attention lead to frequent need of repairs. The intelligent reader can multiply cases for himself. and apply the lesson that we wish here to enforce.

THE ECONOMISER EXPLOSION AT MIDDLETON JUNCTION.

After a lapse of five months the Board of Trade Report of Preliminary Inquiry into the fuel economiser explosion at Middleton Junction has come to hand. It seems a pity that these reports cannot be issued earlier, when they would have a chance of doing some good, instead of appearing at a time when the occurrences to which they refer have almost passed from memory. The report on the above explosion, after briefly describing the construction of the economiser, dilates at considerable length on the occurrences immediately preceding the explosion, arriving at the conclusion that the pressure in the apparatus was probably between 124lb. and 142lb., at which the relief and safety valves respectively were loaded, and a single line serves to refer to the fact that some of the pipes were very thin. This is no uncommon thing in old economisers, and perhaps is as often due to bad casting as to subsequent wasting. The report states the cause of the explosion to be "working the economiser when one or more of the vertical tubes were so far reduced in thickness (principally through the wasting of the internal surfaces) as to be no longer sufficient for the purposes to which they were put." The feed water obtained from the adjoining canal is undoubtedly acid, and therefore quite competent to produce the wasting referred to. We regret, however, that the thickness of the thinnest pipes found amongst the *débris* is not given in the report, as engineers might from that data have formed some idea of the working strength of these tubes. It is known that cast iron subject to high temperatures undergoes a change in molecular structure which affects its strength very much, and hence tests of a new pipe can hardly be accepted as sufficient data for arriving at the working strength of a tube after it has been in wear some years. It seems a pity that this aspect of the explosion has been passed over so lightly in the report. The concluding sentence of the report, which runs as follows, will hardly be endorsed by engineers and steam users in the Lancashire district:—"In this mill five boilers are employed, but four only are used at a time; under these circumstances, I am inclined to think, there is little need for an economiser being fitted, as by easily working all the boilers at once the owners would effect a substantial saving." This seems very much like mistaking the function of an economiser altogether, and confounding it with a steam generator, which it is not. The economiser is a water heater and purifier and smoke consumer, but is certainly not, in a well arranged series, a steam generator; and therefore we do not see how the additional boiler could possibly serve the same purpose as the economiser. The latter takes the hot gases as they leave the boiler flues, and reduces the temperature at the same time that the feed water is heated, and it would be impossible to discharge the gases at this low temperature without an economiser, however easily the boilers were fired, and hence the superior economy of the usual way of working is evident. Besides this, as all steam users will know, the advantage of having a spare boiler for emergency and for cleaning regularly is very great, and one not likely to be readily dispensed with.

MONEY VALUE OF VACUUM.

When engaged in a somewhat extensive indication practice, many years ago, the writer of the present article was often amused at what he considered the almost Quixotic views of some old and experienced engine attendants respecting the importance of maintaining a good vacuum in their condensers and condensing cylinders. To hear some of these old stagers in their convivial moments talking about their engines and boilers, anyone uninitiated might well be pardoned for concluding that the one supreme aim of an engineman's life, or at any rate of anyone who wished to reach the acme of perfection as an engineer, was to learn all the innumerable devices which could be resorted to in order to "improve the vacuum." One man who could produce diagrams from his engines never showing less than 14lb. of vacuum in the cylinder, was regarded as a prodigy, and was generally looked up to by his compeers as the best engineer in a large manufacturing town containing many of the most skilful and practical engineers in Lancashire. Indeed, it was currently rumoured that the maker of a popular indicator in very general use some fifteen or twenty years ago, knowing the general weakness on the part of engineers in this respect, purposely made the low-pressure springs of his indicator weak, or light, in order to show a good vacuum, and a great many engineers would have no other indicator, because it always gave them diagrams showing from ½lb. to 1lb. better vacuum than the cards obtained by any other instrument. Whether the sinister rumour was correct or not, we cannot of course say, but of the great importance attached to the securing of a good vacuum, or, in other words, reducing the resistance to the piston's motion as much as possible, by the great majority of old enginemen, there can be no manner of doubt, and hence the great amount of tightening up of glands, lubricating, and general attention to any points by which the possibility of the admission of air into the cylinders, etc., could be prevented, whenever an engine was about to be indicated. Very little consideration will show us that this apparently exaggerated view of the great importance of having a good vacuum is, after all, not so Quixotical as at the first blush appears, as the improvement of the vacuum, say a couple of pounds in a large engine, will often mean a saving in fuel equivalent to a man's wages. Let us take for example the case of a pair of engines with, say, condensing cylinders 44in. diameter, and a piston speed of 600ft. per minute—a by no means high or uncommon speed at the present time. Such a cylinder would have a piston constant or multiplier of a little over 26, that is to say, every pound of mean effective pressure on the piston would develope over 26 indicated h.-p. An improvement of only 1lb., therefore, in the vacuum obtained on the piston would mean a clear gain of over 26 indicated h.-p. without any extra cost whatever, and if we assume the engine to be working with a consumption of, say, 3lb. of coal per indicated horse-power per hour, we get 26 × 3 = 78lb. of coal saved per hour, or nearly two tons of coal per week, the money value of which would amount to something like fifteen shillings. It is no uncommon thing to meet with engines working with a vacuum in the cylinder of not more than from 9lb. to 10lb. per square inch, and an engineer who is able to improve this to 12lb. or 13lb., such as is obtained in most instances with well designed engines, would at once be able to make a clear saving for his employer of about 45s. per week.

It will be seen, therefore, that attention to the vacuum is a point of great pecuniary importance in the tending of large engines, apart from improved turning and easier running, and care in this respect is well repaid in every way. The causes tending to the deterioration or impairment of the vacuum, and thus leading to waste of fuel, we shall leave for consideration in a subsequent article, but amongst our large circle of practical readers we know there are many who could communicate valuable information on this subject from their own experience, and we invite contributions from practical engineers, whose communications we shall be happy to print for the mutual benefit of all our readers, steam users, and others interested in the economical supply of steam. Those who are unaccustomed to writing need have no hesitation in committing their experiences to paper, as any error in spelling or composition will be corrected, and any practical information they may have to communicate will be put in readable form before being set up in type. We know that the correspondence which has previously been published in our columns from working engineers has proved of real benefit, and makers of apparatus have profited by the suggestions thrown out and hints given by those who have had everyday experience of the working of their productions. Hence, as this must ultimately prove of advantage all round to all concerned, we trust none will hesitate to make our columns a medium either for communicating the results of their experience, or for asking questions which may elicit practical and useful information from those who from actual everyday practice are best able to give it. Large numbers of working engineers we know can impart much information, even to the most initiated and best informed, as to the struggles they have had in finding out the causes of impairment, and especially in reference to the measures they have successfully adopted in improving the vacuum, the money value of which we have briefly endeavoured to illustrate, and to which we purpose reverting in an early number.

The Cost of Fog.—In London the cost of a single day of fog, in extra gas burned, is between £7,000 and £8,000.

MACHINE TOOLS.

As pointed out by Mr. Dixon in his inaugural address delivered before the Manchester Association of Engineers, on Saturday last, the very first requirement of a modern machine tool is accuracy of construction. The facilities for changing work and for solidarity are indispensable things in their way, but these are of little use nowadays if accuracy of construction does not accompany them, and hence the one feature that makers should strive for, and not rest satisfied until it is attained in an increasing degree in every tool that is constructed in the shop, is the one mentioned above. Strength, of course, is a necessary accompaniment of this first desideratum, as it is impossible for a machine to turn out good work if its parts are too weak to bear the stresses that will come upon them, and hence solidarity is the next feature to be secured. English machine tools, as a rule, are not wanting in weight, but often enough the metal is merely surplus stuff placed where it is not actually required, while other parts are abnormally weak. Such designs are to be avoided, and the intelligent draughtsman will see that while every part of the machine is amply strong for the work it is intended to perform there is no waste of metal. A perfectly designed machine is a treat to see, and one that we are glad to think is becoming rapidly less rare than it was a few years ago. The concluding remarks of Mr. Dixon's address, which are printed in another column, will offer to all concerned food for thoughtful consideration.

MINERS' SAFETY LAMPS.

At the meeting of the Manchester Geological Society, held at Wigan, on the 6th inst., several important improvements in the construction of mining safety lamps were introduced to the notice of the members.

Mr. Hollingworth, F.G.S., honorary secretary, read a paper by Mr. Emerson, Bainbridge, upon his patent improved safety lamp, which consists of four parts only: (1) the shield, (2) the gauge, (3) frame holding glass, and (4) bottom of lamp or oil well. The air is fed to the flame through the side of the lamp, the gauge cap is made of sheet copper, and the lamp has been tested in a highly explosive atmosphere, moving at a velocity of 30ft. per second, without explosion. It has also a number of minor improvements adapted from other lamps.

Mr. Henry Hall, inspector of mines for the West Lancashire and North Wales districts, exhibited and explained his new arrangement of shielded Davy lamp, for the use of firemen and shot firers, which he had himself tested in the mine during the past two months with good results. It is fully as sensitive to gas as an ordinary Davy, the air for feeding the flame being introduced near the top of the lamp. When the lamp is unlocked and the shield and upper part of the lamp unscrewed, and taken off, the flame is still surrounded by the gauge, and is then ready for use for shot firing, by means of a wire, in the same way as with an ordinary Davy lamp, and the flame is not exposed. The lamp is of very handy size, and appears very suitable for its purpose..

Mr. Seale explained Mr. Radcliff's improved shield for Marsant and other lamps, which can be fixed on the lamp by a simple self-locking arrangement. After the gauge, etc., in the locked safety lamp, has been inspected by the fireman, and cannot then be taken off without taking the lamp entirely to pieces, thus ensuring that the parts of the lamp shall be properly kept in order.

Another novelty was Mr. Henry Bramall's (of Pendlebury Collieries near Manchester), patent lead-rivet making tool; a simple and ingenious tool for moulding the rivets now so much used for locking safety lamps. We hope shortly to fully describe and illustrate this tool, by which rivets can be made in larger quantities, at little cost, from scrap lead.

One of the leading features of the meeting, however, was the exhibit of a portable electric safety lamp, by Mr Oswald Swete, the electrician of the Sun Portable Electric Lamp Co., of 43, Coleman-street, London. The lamp is the invention of Mr. Urquhart, and weighs 3½lb.; it affords a light of 2½ candle power, for about 12 hours, and consists of a "primo-secondary" battery of two cells, of a new construction enclosed in a teak case; the globe containing the filament of cotton being enclosed in a metal case, except at the front, where the light shines through an ordinary bull's eye glass. The globe is held in position by a spiral spring which minimises shocks and reduces the breakages. Mr. Swete stated that it had been used constantly for the past two months in the laboratory, but had only recently been taken into the mine, and that the working cost of the lamp would be no more than 3d. per week. The basis of this calculation is that a globe, *i.e.*, the filament will last 1000 hours at a cost of 2s. 6d. = about 1½d. per week, and that a one-unit Dynamo costing £20 will suffice to charge 150 lamps in 3½ hours. The battery plates of peroxides of zinc are immersed in a solution containing sulphuric acid; the peroxide is converted into zinc sulphate, with liberation of oxygen and hydrogen which forms water, that is, whilst the lamp is working; when charging the reverse process takes place, and theoretically there is no waste. The cost of the lamp complete is at present 21s., but when made in quantities this is expected not to exceed 15s. to 12s. 6d. Of course, almost absolute safety from explosion is secured by this class of lamp, and if the economic results are as above stated, there is no question that this lamp will cause a revolution in the lighting of coal mines. One gentleman present offered to place an order for 500 lamps at once, if the results would be guaranteed. The chief items of cost are the renewal of globes, and the waste in the battery, and both these items can only be ascertained by experience. The power for the Dynamo is a secondary matter, as there is commonly surplus burning power at a colliery.

ROYAL AGRICULTURAL SOCIETY OF ENGLAND.

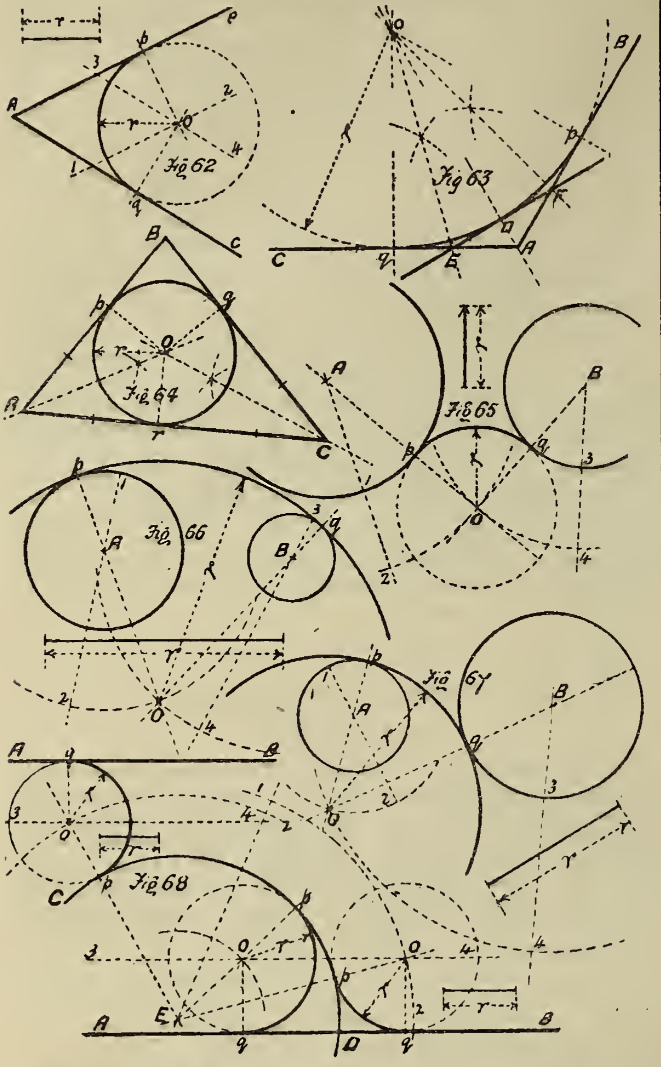
The implement regulations of the Nottingham Show of this Society, to be held on the 9th July next and the four following days have now been issued. The Society offers for competition the following prizes: Class 1—Hay and straw presses worked by steam power, first prize £30, second prize £20; Class 2—Hay and straw presses worked by horse power, first prize £20, second prize £10; Class 3—Hay and straw presses worked by hand power, first prize £20, second prize £10; Class 4—Best apparatus for condensing milk, suitable for use on a farm, £25. The price charged to exhibitors for ordinary implement shedding has been reduced from 3s. to 2s. 6d. per foot, and the distinction in price between strictly agricultural articles and articles required for agricultural estate work has been abolished. The price of special shedding is now uniformly 7s. 6d. per foot, except for non-agricultural articles, which remain at 20s. per foot. Open ground space will, however, be charged 3d. per foot, instead of 3d. and 2d. as before. The charges made to exhibitors for printing in the catalogue their list of exhibits have been reduced 25 per cent. The general regulations are much the same as last year, except that there is now no restriction as to the pressure of steam in engines or boilers. The working pressure must, however, be declared on the exhibitor sending in his certificate and specification. A new regulation has been added forbidding the entrance into the show-yard of petroleum or other inflammable substances with a flashing point of less than 73° F., as described in the first schedule of the Petroleum Act of 1879. The entries for implements close on the 31st March.

A MONEY-MAKING LOCOMOTIVE.

Mr. F. W. Webb's little model of the compound locomotive Dreadnought, which has been the round of all the recent exhibitions, appeared last year at Manchester, and was more than usually successful in gathering in the pennies which act as the motive power to set it in action. The total amount received by it was £127. 7s. 3d., which has been distributed in various sums among twelve medical charities, the poor of Crewe, and the attendants in charge of the engine. Mr. Webb finds that the engine wheels made 183,396 revolutions during the time the exhibition was open, equal to travelling a distance of 83 miles, and consequently it earned £1. 10s. 8d. a mile. Mr. Webb's engine earnings and working expenses are without parallel.—*Engineering.*

LESSONS IN MECHANICAL DRAWING.—XI.

By Prof. A. MacLay, B.Sc., C.E.



EXERCISES IN PRACTICAL PLANE GEOMETRY (CONTINUED).

Ex. 53, figs. 62 and 63.—*To draw an arc of a circle joining two straight lines.*

(a) When its radius is given (see fig. 62). AB and AC are the lines, and *r* the given radius. At distances *r* draw parallels 1 2 and 3 4 to AB and AC, intersecting at O. From O drop perpendiculars O*p* or O*q*, and with O as centre, radius O*p* or O*q*, describe the required arc between *p* and *q*, the points of contact.

(b) When its position is given (see fig. 63). AB and AC are the lines, and D the position of the middle point of the arc. Draw AO, the bisection line of the angle BAC, and EF at right angles to it through the given point D. Next bisect either of the angles FEC or EFB. The bisection line will intersect the central line AO at the point O, which is the centre of the required arc. From O drop perpendiculars O*p* and O*q* on AB and AC, and with O as centre, radius O*p* or O*q*, describe the required arc between *p* and *q*, the points of contact.

Ex. 54, figs. 63 and 64.—*To draw an arc of a circle touching three straight lines.*

(a) When the lines are disposed as BF, FE, and EC, in fig. 63.

(b) When the lines form the sides of a triangle, as in fig. 64. In both cases the construction is to bisect the angles between adjacent lines. The bisection lines so found intersect at the required centre. In fig. 63 the bisection lines are EO and FO, and in fig. 64 AO and CO. Perpendiculars from O give the points of contact, *p q*, and *p q* and *r* respectively.

Ex. 55, figs. 65, 66, and 67.—*To draw an arc of a circle of given radius touching two given circles.*

(a) When the arc *excludes* the given circles, fig. 65. A and B are the centres of the given circles, and *r* the given radius. From A and B draw any radial lines, such as A2, B4. Beyond the circumference of each circle cut off distances 1 2 and 3 4, each equal to given radius *r*. Then with centre A, radius A2, and centre B, radius B4, describe arcs intersecting at O. Draw OA, OB cutting the circles at *p* and *q*, and with centre O, radius O*p* or O*q*, describe the required arc between *p* and *q*, the points of contact.

(b) When the arc *includes* the given circles, fig. 66. A and B are the centres as before, and *r* the given radius. Through A and B draw any diameters, and on these, when produced, measure off from one extremity the distances 1 2 and 3 4, each equal in length to the given radius *r*. Then with centre A, radius A2, and centre B, radius B4, describe arcs intersecting at O. Draw OA, OB cutting the circles at *p* and *q*, and with centre O, radius O*p* or O*q*, describe the required arc between *p* and *q*, the points of contact.

(c) When the arc *includes* one circle and *excludes* the other, fig. 67. A and B are the centres, *r* the given radius. Through A draw any diameter, and produce it so as to make length 1 2 equal to *r*. From B draw any radius, such as B3, and produce it, cutting off 3 4 equal to *r*. With centre A, radius A2, and centre B, radius B4, describe arcs intersecting at O. Draw OA, OB cutting the circles at *p* and *q*. Then with centre O, radius O*p* or O*q*, describe the required arc between *p* and *q*, the points of contact.

Ex. 56, fig. 68.—*To draw an arc of a circle of given radius, touching a straight line and a circle.*—Fig. 68 shows three relative positions of line and circle. AB is the given straight line, and CD the given circle described from centre E. Draw an arc of a circle 1 2 concentric with CD, at a distance *r* from it, and a straight line 3 4, parallel to AB, at the same distance *r* from it. Draw line EO, intersecting circle CD at *p*, and drop a perpendicular from O upon AB for the point *q*. With centre O, radius O*p* or O*q*, describe the required arc between *p* and *q*, the points of contact.

[The principle of the construction, in the preceding exercises, 53 to 56, is simply that of finding a point which satisfies the condition of being at a given equidistance from two lines, from two circles, or from a line and a circle, as the case may be. In the case of lines we find parallel lines at the given distance, as in figs. 62 and 68; and in the case of circles we draw concentric circles at the given distance, as in figs. 65, 66, 67, and 68. The intersections of these parallel lines or concentric circles with one another, satisfy the above condition, and form centres from which the required joining arcs may be drawn. In figs. 63 and 64 the bisection lines of the angles may be looked upon as the lines (*loci*) upon which the intersection of all equidistant parallels would take place.]

APPLIED MECHANICS.

ELEMENTARY STAGE.

10. What is steel? How may a piece of steel be hardened and tempered? Describe, as an example, the process of making a chisel for chipping cast-iron.

Steel is essentially a compound of iron and carbon in varying proportions, the more carbon it contains and the "higher" the steel is, that is, it is harder, can resist greater tensile or other strains, and is finer grained and less ductile than "low" or "mild" steel, which has less carbon. Other substances, such as manganese and silicon, are found in steel in very small quantities, but the chief difference in the composition of steel and iron is in the amount of carbon present. Steel may be hardened by heating to a cherry red and cooling it suddenly in water, and it may be tempered by gradually re-heating it after hardening, when a succession of colours will come over the steel (which should be previously brightened), and when the colour, which is found by experience to correspond to the required degree of hardness, is seen, the article is thoroughly cooled again, which completes the operation. The following is a description of the process of making a chisel for chipping cast iron. The chisel is forged from octagonal steel, flattened for about half its length to a thin tapering form; after forging, the chisel has to be hardened and tempered; it is hardened by heating to a cherry red and cooling for about half-an-inch from the point. It is then brightened with a stone, and the heat left in the stem gradually spreads up the cooled part, producing the varying colours before-mentioned, till a deep reddish brown is seen, when the chisel is suddenly cooled. It is now ground with a bevel on each side, and is then ready for use.—A. G. K.

[Good replies from Tennant, S. B., R. L. F., W. Wass, etc.]

11. A beam of timber, rectangular in transverse section, is 2in. broad, 3in. deep, and 4ft. in length, and rests upon supports at its ends. The breaking load on the centre is 2,000lb. What would have been the breaking weight if the beam had been 4in. deep, 2in. broad, and 4ft. between the supports, but loaded at a distance of 1ft. from the end?

Let W = load on the beam, l = length of beam. Then in the 1st case, as the load is in the centre of the beam, the reactions at either end each $= \frac{W}{2}$, the leverage of this reaction about the point of application of the weight $= \frac{l}{2}$ $\therefore$ the bending moment about this point $= \frac{W}{2} \times \frac{l}{2} = \frac{Wl}{4}$; in the 2nd case as W is 1ft. from one end and 3ft. from the other, the reaction at the end nearest to $W = \frac{3}{4}W$, and the other $= \frac{W}{4}$ $\therefore$ the bending moment about the point of application of $W = \frac{3W}{4} \times \frac{l}{4} = \frac{3Wl}{16}$. The strength of a beam varies as the breadth, as the square of the depth, and inversely as the length; in the two beams the length and breadth as the same, so they will not alter the breaking strength; the ratio of the squares of the depths are as $3^2 : 4^2$, and of their bending moments as $\frac{Wl}{4} : \frac{3Wl}{16}$ or as $\frac{1}{4} : \frac{3}{16}$, and the bending moment being less in the 2nd case the beam will carry a greater load $\therefore$ breaking weight of 2nd beam $= \frac{2000 \times 4^2 \times 16}{3^2 \times 3 \times 4} = 4740{\cdot}74$lb.—G. W. W., Manchester.

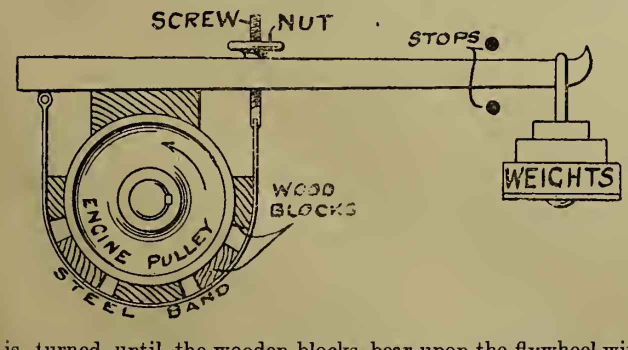
[Correct answers from H.G.C., Y., W., etc.]

ADVANCED STAGE.

29. Sketch and describe some form of dynamometer, and explain how it is applied for ascertaining the power given out by a prime mover.

The power of a portable engine is tested by passing a strap or belt over the fly-wheel, which is 5ft. in diameter; one end of the belt is secured to a spring balance, and a weight of 300lb. hangs on the other end. What is the horse-power of the engine when the balance registers a tension of 180lb., and the fly-wheel makes 150 revolutions per minute?

A common form of dynamometer is shown by the sketch herewith. It is placed on the flywheel of the engine to be tested, or on a pulley or similar attachment to the main shaft of the prime mover as shown. After the engine is started the nut is turned until the wooden blocks bear upon the flywheel with sufficient force to cause such friction between the blocks and the rim of the wheel that the weighted lever will be lifted, and will float between the stops. The stops are firmly fixed, and their purpose is to prevent the weighted lever being either carried too far round with the wheel, or dropping down in the opposite direction. The weight on the end of the arm must be varied until the flotation of the lever is effected; then, when the blocks, lever, and weights are thus supported by the revolving flywheel, we may consider that at any and every instant (during the period of flotation) they are in one with that flywheel, and are turning about its centre. Now we require to know the weight of the whole apparatus and the position of its centre of gravity, and we shall have, in effect, a weight which is being continuously lifted by the arm of an imaginary wheel, whose radius is the distance (measured perpendicular to the line of pull of gravity) of the centre of gravity of the apparatus from the centre of main shaft. The work done by the engine in HP. =



$$\frac{\text{Weight of whole apparatus} \times \text{circum. imaginary wheel} \times \text{revs. per min.}}{33{,}000}$$

For the second part of the question, the weight being 300lb. it is evident that the downward pull of the remaining 120lb. is balanced by the revolving flywheel, which then is doing work represented by $\frac{120 \times 5 \times 3{\cdot}1416 \times 150}{33{,}000} = 8{\cdot}56$ HP.—Wm. Jno. Tennant.

[Correct answers from H.G.C., G.W.W., A.G.K., S.B., etc.]

SHAFTING AND PULLEYS.

The general progress which mechanical engineering has made during the last quarter of a century has affected not only the more imposing class of works, such as bridges, steamships, etc., but also almost every detail of the workshop and factory. Take, for instance, the item of shafting and accessories. Within the period mentioned, shafting, instead of being made of wrought iron, has come to be made of steel in all the newer and higher class factories. The bearings, instead of being rigid, are now usually of the type known as swivel bearings. These not only accommodate themselves to any irregularity in the movement of the shaft, but they are longer than they used to be made, and therefore are more enduring, and they are furnished at the ends with cups to avoid the annoyance of the continual dropping of dirty oil. If lubricated with needle lubricators they require no attention except at long intervals, and there is no liability to run dry. Pulleys instead of being solid are now always in halves, so that they can be slacked and shifted, or removed altogether in a very short space of time. The mere screwing together of the two halves is sufficient to fix a pulley to the shaft without the necessity for keys, as was formerly the case, and which so often threw them out of truth. As regards very large pulleys, the construction of these of wrought iron or steel by building them up, as it were, has become a large and important business, and fortunes have even been made out of the manufacture of them. The first person who advocated and made large wrought iron pulleys was the late Mr. Joseph Rodgers, of Leeds, and large quantities of them are still made by Messrs. Hudswell, Clark, and Co., his late partners. Several varieties of the same thing have since been put upon the market, until these enormous wrought iron pulleys may be seen at all our industrial exhibitions, where they present quite an imposing appearance.—*The Engineer*.

VELOCITY OF FLOW IN THE PANAMA CANAL.*

This report was made by the Académie des Sciences at the request of Sir F. de Lesseps, who supplied a series of observations on the height of the tides at Panama and Colon respectively, and other important information. Analysing these observations, employing the necessary hydraulic formulas, and taking advantage of similar observations made on the Suez Canal, certain velocities were calculated and tabulated. From these it results that the greatest velocity occurs on the Pacific side, and precedes the time of flood-tide. The greatest negative velocity takes place on the Pacific side, and is just before ebb-tide. The Pacific and Atlantic Oceans are assumed of the same level, on the information of the engineer of the company, and no allowance is made for atmospheric influences or extraordinary tide in the Atlantic. Under these circumstances the velocity in the canal cannot exceed 2½ knots—a velocity which can only last for a few hours, and should not affect the navigation of steamers in the canal.

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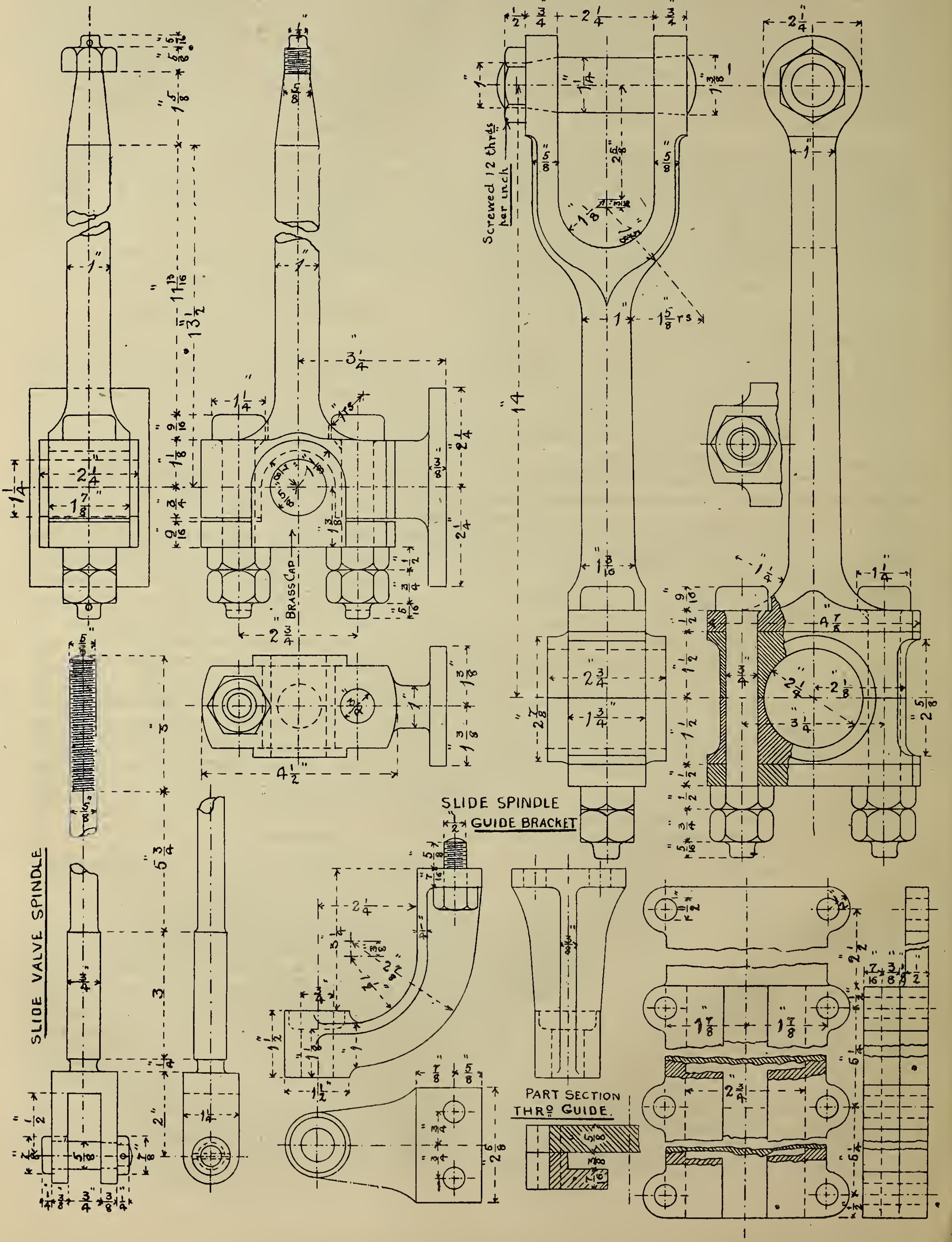
* Institute of Civil Engineers, Foreign Abstract.

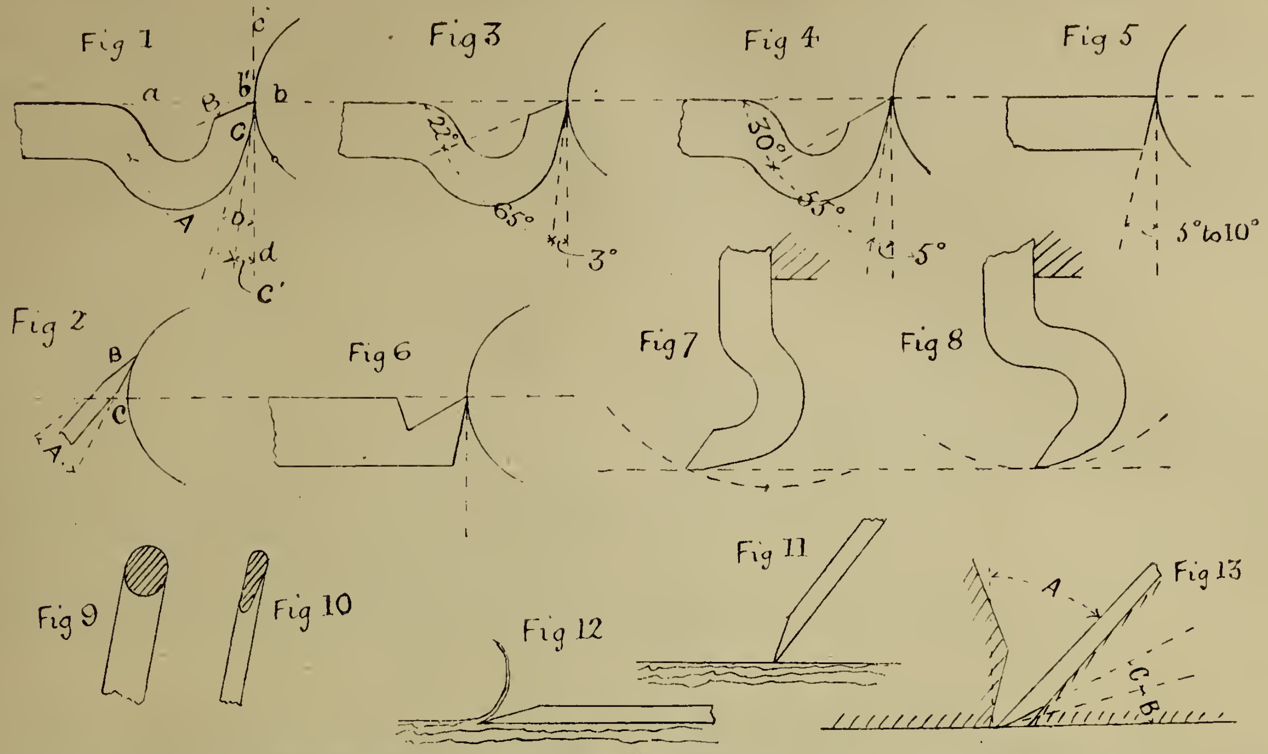
WORKING DRAWINGS.

LAUNCH ENGINES, II.—DETAILS of CONNECTING & PISTON RODS, &c.

Scale 4in. = 1ft.



TOOL ANGLES.—I.



By the cutting angle of a tool we mean the angle included between the top or cutting face, and the bottom face, which last forms with the tangent to the work the angle of relief, or the clearance angle. Thus, in the common roughing tool used for iron and steel, fig. 1, A is the cutting angle, also called the tool angle, being included between the cutting face, B, and the bottom face, C. Neither this angle nor the slope of the faces B and C are arbitrary; the shape of the tool is not due to fancy, or chance, but is one which has been evolved by a happy union of theory and practice. For suppose there were no angle at B, but that the top face of the tool coincided with the line *a b*, such an instrument could not cut iron at all, but would only scrape it; or, leaving the top face as it is, and making the bottom face coincide with the tangent line *c d*, the cutting point *b'* would grind against the work, and become abraded or burnished. This lower angle, *c'*, is therefore imparted to diminish friction simply, hence its name—"clearance" or "relief" angle, a term which sufficiently denotes its sole function; since but for this, the bottom face should coincide with the line *b d*. If, on the other hand, B is brought down much lower towards the tangent line, the consequent reduction of angle A would weaken the tool to such an extent that the cutting edge would not be sufficiently permanent to operate on the harder metals, but would crumble away, though yet sufficiently strong to attack the softer metals, as copper, lead, and tin, and also wood. B is therefore placed at that angle which experience has proved to be the best for the kind of metal or other material upon which it has to operate. The angle B is often termed the "top rake" of the tool, and C the "bottom rake."

Take now another tool of quite a different character, fig. 2. Here is a wood turner's side chisel, used indifferently for hard and soft woods, and placed in the best possible position for cutting, that is, at a tangent to the work. In other words, the cutting face B is presented as nearly as is practicable in the direction of the line of the shaving which has to be removed, while there is also the clearance angle C beneath, leaving the cutting angle A very much more acute than that in fig. 1. The reason why a tool of this kind would not do for cutting iron is not that there is anything unsuitable in the principle of its formation, for it is evident the principle is identical in each, but simply that the small angle given here would leave the tool much too weak to stand the work imposed upon it by the harder material iron, causing it to lose its edge immediately. In all cutting tools, therefore, the aim is to obtain the angle most suitable for the cutting or penetration of the particular material to be operated upon, and to provide the backing of metal necessary to give adequate and durable support to the cutting edge, and since the clearance angle represents so much taken out of the supporting metal, causing a corresponding diminution in strength, it is for this reason to be kept as small as practicable. These principles apply to all tool formations, however varied the shapes themselves. Let us pursue the application of the elementary principles into the diverse forms which tools assume.

We find that in all true cutting tools the nearer the top face can be made to approximate to a tangent with the material to be cut, the better will they operate. The softer the materials, the closer is the approximation; the harder the materials, the farther does this face depart from the tangent and approach to the perpendicular. But every true cutting tool must have its top face at an angle, for one presented perpendicularly to the work cannot properly cut, but only scrape. Cast steel and cast iron are the hardest materials with which we have to deal, hence the tool angles for these represent the maximum, as those for cutting soft wood represent the minimum practice. Fig. 3 shows a typical roughing tool, suitable for turning cast iron, or properly annealed cast steel. Such a tool will stand well, keeping its edge for several hours. Wrought iron and forged steel are softer, and tools for these will bear a lesser angle, as shown in fig. 4. It need hardly be said that, as regards actual shop practice, the tool angles employed for these metals often vary considerably from the figures, which are given as representing good standard and typical proportions. For example, in principle there should be very little clearance angle, or only just sufficient to prevent friction between the tool point and the material. Whatever is given in excess of this, detracts from the solidity and strength of the cutting angle. In place of from 3° to 5° only, as shown in the figures, the writer has seen as many as 15° or 20° on tools turning wrought iron. This is excessive and unnecessary, and cannot conduce to efficiency and durability; yet, as a matter of fact, angles approaching to these are not at all exceptional. The angle of top rake is not subject to so much variation; for when it is increased too much, the tendency of the tool to "draw in" to the work becomes very pronounced. Tools ground a very little thinner than fig. 4, still held in the slide rest, will turn hard wood sweetly, and also copper, but, strange to say, not brass, for brass cannot be turned, but only scraped, with a tool presented as in fig. 5, perpendicularly.

Mr. Molesworth.—It is believed in official circles in Calcutta that Mr. Guildford H. Molesworth, the Consulting Engineer to the Government of India for State Railways, will remain in office for about a year longer.

THE LATE STRIKE AT BOLTON.

The award of Mr. S. Pope, Q.C., recorder of Bolton, who was selected as umpire by the members of the Board of Conciliation and Inquiry, formed in accordance with the terms of settlement of the recent strike in the Bolton machine making and engineering trades of the town, has been made, Mr. Alderman Dobson, on behalf of the employers, and Mr. R. Barlow, secretary to the Joint Committee of the men, on behalf of the men, each receiving a copy of such award on Tuesday. The decision of Mr. Pope, is briefly that no advance is warranted on the evidence produced before him by the respective parties.

THE USE OF CAST STEEL IN LOCOMOTIVES.—I.*

In this communication it is not the intention of the author to deal at length with the chemical constituents and properties of cast steel, but rather with the details for which it can be conveniently and economically applied in the construction of locomotives. Through the courtesy of several steel manufacturers, he has, however, been able to obtain some information on this subject, and also some results of tests as to the strength of steel castings.

The steel from which the best castings are obtained is made chiefly from a mixture of Scotch and Swedish Iron, its melting-point being about 3,500° Fahrenheit, while that of cast-iron is about 2,000°; owing to this extremely high melting point, the contraction of steel in cooling is nearly double that of iron, being $\frac{1}{4}$in. instead of $\frac{1}{8}$in. to the foot.

To avoid the danger of the castings flying during this excessive contraction, some of them, of a form most liable to this accident, are taken out of the mould and put into an annealing furnace as soon as the metal has fairly set; if this is not done they are put into the furnace after they have cooled down, and are maintained at a temperature of about 1,700° Fahrenheit for not less than twenty-four hours, and then allowed to cool without the admission of air, the time occupied in the process depending upon the size of the casting, larger articles requiring a longer time than smaller ones. The effect of this annealing process is to soften the castings, otherwise they would be too hard to admit of machining. Annealing also very considerably increases the per centage of reduction of area and elongation. Planishing under a hammer, where possible, is of material advantage in toughening and strengthening the castings, but this of course can only be carried out in exceptional cases.

The mechanical properties of steel castings are greatly affected by the quantities of sulphur, phosphorus, manganese and silicon which they contain in proportion to the quantity of carbon, and also in the proportion which these elements have to one another. The presence of sulphur impairs their soundness, and causes red-shortness, and as it is often necessary to work them hot, this is of course a great disadvantage, the amount therefore should never exceed 0·1 per cent.

Phosphorus has the reverse effect of sulphur, producing cold-shortness; but the amount admissible depends greatly upon the carbon; its presence in small quantities in castings is beneficial, as it causes the metal to cast sounder, and thus, although the actual strength of the metal is slightly reduced, that of the casting as a whole is increased, and it is sharper in outline by reason of the greater fluidity of the molten metal.

There are several beneficial results from the presence of manganese in the metal, the chief being that having a greater affinity than iron for oxygen and sulphur, it unites with these impurities; and although some of them must still remain in the metal, yet they probably exist only as mechanically mixed oxide and sulphide of manganese, instead of being in chemical union with the metal itself. The amount of this element varies in steel castings from 0·3 to 0·7 per cent.

Silicon produces both red-shortness and cold-shortness; the quantity which may be present without having any very serious effect on the metal is, however, governed by the relative proportion of carbon; with only 0·1 per cent. of carbon, silicon may safely be present to the extent of 0·5 per cent.; but with 0·5 per cent. of carbon the same amount of silicon makes the metal both red-short and cold-short. Although as far as the material is concerned, the strength is reduced by the presence of silicon, yet in producing sound castings it is a valuable ally, as the addition of silicon in the form of highly siliceous pig-iron, containing a large percentage of manganese, prevents the ebulition of gases during the solidification of the metal.

The more nearly steel approaches the simple alloy of carbon and iron so much the better it is, all other elements vitiating its value, although as shown above they may have a good effect during its manufacture. The amount of carbon in steel castings varies from 0·25 to 1 per cent., but above 0·5 it has the effect of materially reducing the elongation, although the ultimate tensile strength is not affected. The following is the analysis of steel taken from a cast steel motion plate.—

	Per cent.
Sulphur	0·07
Phosphorus	0·17
Manganese	0·38
Silicon	0·20
Carbon	0·27
Iron by difference	98·91
	100·00

The average tensile strength of cast steel is about 35 tons per square inch, although a much greater strength may be obtained from some specimens. It is especially adapted for such details, which, if made in wrought iron, would necessitate complicated and expensive forgings, and for which cast iron is not suitable owing to its small tensile strength, otherwise its price at present is such as to seriously affect its use; but probably as the demand increases, the competition in its manufacture will also increase, and the price be reduced.

MODERN MACHINE TOOLS AND THE ENGINEERING TRADE.

At the meeting of the Manchester Association of Engineers, held on Saturday evening at the Grand Hotel, Mr. S. Dixon, the President, delivered his inaugural address. The subject on which he had elected to speak was "Modern Machine Tools," and in order that the address might be kept within reasonable bounds he confined his attention to those machine tools met with in almost all the chief engineering establishments of the Manchester district, this being one of the most important centres of general engineering work, and the recognised head-centre of machine tool construction. Glancing for a moment or two at the condition of machine tools in the past, he traced their development, and then proceeded to comment upon some of the more recently constructed tools. Speaking of the leading features of the modern machine tools, he placed accuracy of construction first of all. Solidity of construction, thereby giving vastly increased capacity for production, he placed second. The third point he noted was the development of appliances for the rapid changing and accurate setting of work; and the fourth was the special adaptation of almost all machine tools to the particular requirements of each workshop. Towards the conclusion of his address the President offered a few remarks upon the future of the engineering trade. That foreign competition was extremely keen everyone doing any continental trade was, he said, well aware, but it was only by visiting the various workshops and personally investigating the question that the true magnitude and nature of that competition was revealed. Formerly, the foreign engineer came to England, and it was simply a question of quoting for machinery delivered, say in Manchester, with numerous extras for packing, etc., and with terms of payment, such as cash on completion. This was a very comfortable proceeding, in which the English makers were never acquainted with the actual cost of delivery; but to-day all this was changed, and it was necessary to quote for machines delivered at the customer's door, no matter where, and with terms of payment in accordance with the usages of the country, and often with a legalised residence in the country, so that any necessary legal action may be taken in the customer's own country. A late member of the Association once stated his conditions for doing work for foreigners in the following terms:—"Ah mun have one half before ah touch th' job, and t'other half before tha touches it." Such terms would have to be modified slightly at the present time. With reference to a suggestion that Protection might with advantage be resorted to, the President took leave to say that any return to Protection on the part of Englishmen was entirely out of the question, for immediately they began to tax anything the cost price of all their productions would rise, and they would stand so much the worse in all their competition. Had he anything, then, to suggest? He could only say that in his opinion there was no royal way, and none but the one upon which they had long been journeying. The great thing was to improve their pace by increased economy in production, by the improvement of their business capacities for dealing with foreigners, and by the continual exercise of that fertility of mind in invention which had earned for Englishmen the respect of the world, and which caused the foreigner often to exclaim that an Englishman was always practical. Again, he thought it highly important that they should give a thorough training to their workmen, not merely how to use tools, but how to use their brains to the greatest advantage. He would, in addition to his technical training, supply him with sound geographical and commercial knowledge, so that the workman might be fully acquainted with the true nature of the competion which threatened him all over the world. Were this but fully realised, he had not the slightest doubt that, once Englishmen felt that they were pitted against foreigners, they would be able easily in the present hours of labour, by a thorough co-operation, to increase their production by at least 20 to 25 per cent. One must not always think that the high protective duties in any country were against England; often the competition was among three or four nationalities apart from the internal competition. In Italy, for instance, the English engineers had to compete with Swiss, German, French, Belgian, and sometimes Austrian firms, but the heavy duties were levied on each alike. He often wished that one of the leaders from whom men usually took their ideas really had to follow up some prominent foreign inquiry, and there take his turn at an interview with some engineer having various tenders before him, hear his remarks thereon, and have to plead his cause probably in a strange language. Whilst doing so he would probably remember that he had left the representatives of firms from two or three different countries in the anteroom, all eager for the fray, and perhaps ready and able to make concessions of enormous extent to secure the order. He would then find out what competition really was, when a man had got down to the quick, and when with a thorough knowledge of the prime cost before him, he felt that it was not a question of profit, but the fear of positive loss.

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* Paper by A. J. Hill, Wh. Sc., read at a meeting of the Students (Inst. of Civil Engineers), and awarded a Miller Prize in the Session 1886-87.

THE USE OF OPEN-HEARTH STEEL.

At the ordinary meeting of the Institution of Civil Engineers, held on Tuesday, the 10th of January, the President, Mr. Bruce, being in the chair, the paper read was "The Use and Testing of Open-Hearth Steel for Boiler-Making," by the late Mr. Hamilton Goodall, Assoc. M. Inst. C.E.

This paper gave the experience of the author in the use of open-hearth steel for boiler-making since the year 1875, and described numerous experiments to ascertain the cause of the difficulties met with in working the plates. To avoid spoiling a plate by taking pieces from it for the purpose of testing, a drifting-test was adopted, in which washers were prepared from the material removed from the plates in making rivet-holes, and drifted in a special machine to the bursting point by means of a series of drifts, having a taper of $\frac{1}{4}$ inch in 5 inches. In the majority of tests the washers were drilled out at right-angles to the surface of the plate, but in some cases they were drilled out parallel to the surface; the outside diameter of the washers was $\frac{11}{16}$ inch with a drilled hole $\frac{15}{64}$ (0·234) inch in diameter. Tests were also made to ascertain the load on the drift necessary to break the washer, and to establish some relation between the elongation of a washer and the elongation in a length of 8 inches of plate. Preliminary tests, with washers cut from shell-plates, having an average tensile strength of 26 tons per square inch, gave an average drifting diameter of 0·645 inch; from back tube-plates and furnace stiffening-rings it was 0·644 inch, corresponding to an extension of 27 per cent. in 8 inches. These sizes were taken as the normal diameters for a good plate. The investigations of the author were specially directed to obtain a solution of the difficulties experienced in using steel plates, and included experiments on the welds of furnaces, the effects of hammering, of compression, of punching and shearing, of flanging, of annealing, and tests of defective plates.

With respect to welds of furnaces, tests were made with washers taken from five stiffening-rings, flanged after welding; three of them were good welds and gave an average drifting diameter of 0·447 inch; the diameter of the other two was only 0·328 inch; a diameter of 0·406 inch was considered to indicate a fairly good weld. In a further test of washers from another stiffening ring $\frac{1}{2}$ inch thick, the diameters varied from 0.625 inch to 0·312 inch, the elongation being reduced to about 3 per cent. in 8 inches. This plate manifested no outward signs of being damaged.

Tensile-tests proved that heating the ends of shell-plates, and hammering to the required curve for butt-straps or lap-joints was, in some cases, injurious, the elongation having been reduced from 28 down to 6 per cent. in 8 inches. The plates were then set up cold, as tensile-tests indicated that apparently no harm was done by this. But a number of drifting-tests soon showed that the effect of cold-hammering was to reduce the ductility of the material; the extent was equivalent to an average loss of elongation in 8 inches of from 5·01 to 7·89 per cent. Nor did annealing restore the ductility, as in all cases annealed washers from the unhammered part of the plate gave a larger drifting diameter than from the hammered part. Cold-hammering was therefore also abolished, and all bending was done in the rolls. Drifting-tests of washers taken from a flanged end-plate, which cracked in riveting, were given. These showed considerable irregularity in the quality of the material, the results leading the author to believe that steel was distinctly inferior to iron in its ability to resist the effects of heating and hammering, which he attributed to an absence of homogeneousness.

Compression did not seem to be injurious. Drifting-tests were made with washers cut from burrs, punched out of plates, and from plates squeezed up in a hydraulic riveter under a pressure of 20 tons per square inch. The thickness of the burrs had been reduced by the compression from $\frac{13}{16}$ inch to $\frac{3}{4}$ inch, and that of the plate from $\frac{13}{16}$ inch to $\frac{3}{4}$ inch and $\frac{25}{32}$ inch. The drifting diameter of the former was 0·614 inch, and of the latter 0·687 inch; hence it was concluded that compression up to 20 tons per square inch was not injurious.

With regard to punching and shearing, experiments were made to determine how much it was necessary to chip off the edge of a plate so treated to prevent its cracking when stretched in flangeing. Washers were taken from near the punched and the sheared edge, and from the solid part of a plate. The result was that the average drifting diameter of washers cut out at $\frac{1}{32}$ inch from the edge, was a little less than from the solid plate; hence an amount of $\frac{1}{32}$ inch was all that it was necessary to remove from the edge of a plate.

When a piece of $\frac{3}{4}$ inch plate was flanged to a right-angle, with a 3 inch inside radius at one end, diminishing to a square corner at the other, washers drilled out of the top of the radius and tested, showed from their drifting diameters that a large radius was preferable to a small one; but that even with a radius the inside suffered from the compression to which it was subjected. The drifting diameter of washers taken from the corner of a shell-plate, which cracked while being thinned under a steam-hammer, varied from 0·5 inch to 0·687 inch, representing a difference of elongation in 8 inches of from 15 to 31 per cent. This method of thinning corners was therefore abolished, where practicable, in favour of scarfing them in a machine, although further test of washers cut from plates worked in both these ways gave results almost identical. A plate overheated through flanging was found not to have sustained so much harm as might have been expected.

The author specially wished to direct attention to the following points:—1°. Was a steel plate damaged by local heating? 2°. If damaged, was it restored wholly or partially to its original strength and ductility by annealing? 3°. Had tests been made to determine these points; or, if not, were any results published to show that a certain percentage of steel plates had failed, while, under precisely the same conditions, the percentage of failure with annealed plates had been less?

From numerous tensile-tests of plates unworked and locally heated, it appeared that sometimes the breaking strain was apparently increased by annealing, and sometimes diminished, the majority being in favour of the latter; with the elongation of the tensile and drifting tests, the reverse was the case. Drifting tests were made with washers cut from the saddle-plate of a furnace, from a top-back shell-plate, and from a furnace stiffening-ring flange. In the former, the average tenacity and ductility were reduced by annealing, while, in the latter, the results with annealed and unannealed washers were practical identical; from this it did not seem that there was any advantage in annealing plates.

With regard to the effects of heat, and respecting defective plates, the results of tensile and drifting tests, taken from a back tube-plate of special quality mild steel, an ordinary back tube-plate, a middle back-plate, and a top back-plate, which cracked or otherwise failed in working, showed in some cases considerable drifting variation, and much irregularity in the ductility of the material. A diagram was given of a possible combination of contiguous particles in a plate, as represented by the equivalent elongation in 8 inches. In the opinion of the author the want of uniform ductility was the only remaining difficulty in the use of steel plates, and one which steel-makers might remove, if they could, by a thorough mixing of ingredients, make a homogeneous material; he believed if this were done, little more would be heard of cracked plates.

Finally, the author stated the results of tests of plates of a higher tenacity than generally used; but the plates had not been specially prepared, and did not represent the best results obtainable. He suggested that if steel-makers could increase the thickness of ingots, and improve the homogeneity of the metal, there was little doubt but that plates of much higher tenacity could be used than at present. Probably in addition to the special mild steel for plates for furnaces, and the other quality, which was the same for flanging purposes and for shell-plates now in use, it might be possible for steel-makers to introduce a third quality for shell-plates only, and by gradual steps to obtain a considerable increase of tenacity of the material. At the same time, a uniform width should be specified for the samples tested, and some stipulations made as to the minimum proportion to be allowed between the breaking strain and permanent set. From figures supplied by Mr. E. D. Leavitt, jun., of Cambridgeport, Mass., of tests of steel-boiler plates, the average elastic limit was equal to 70 per cent. of the average breaking strain; whereas, in specimens tested by the author, it had been as low as 48 per cent., and had never exceeded 66 per cent. The paper concluded with a record of the experience of the author in regard to rejected and spoilt steel plates for boiler making as compared with iron since 1875; the failures in working, and from defective plates, being greatly in favour of steel.

CORRESPONDENCE.

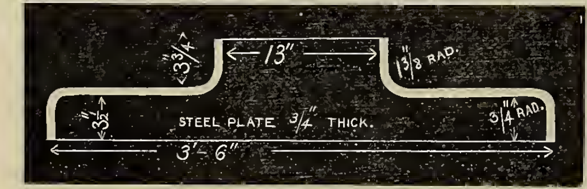
We do not hold ourselves responsible for the opinions of our Correspondents.

PLATE FLANGEING.

To the Editor of "The Practical Engineer."

Sir,—In your description of a bleaching kier, made by Joseph Adamson and Co., Hyde, you mention the flangeing of the end plates as a "feat in boiler construction." I for one cannot see where the "feat" comes in, it is a simple hydraulic flangeing operation which is done daily in all shops having a hydraulic press for flangeing purposes. I herewith send you a sketch of top plates for vertical boilers which I have seen flanged in one heat, and I leave you to judge whether it is not more of a "feat" than the kier ends described in your paper of November 18th, 1887, and referred to in your last week's issue. As a constant reader of your valuable paper from the first number, I take the liberty of sending you this for insertion if you see fit.—I remain, yours truly,

Glasgow, 12th January. A. S.



GRAPHIC REPRESENTATION.

To the Editor of "The Practical Engineer."

Sir,—With your permission I hasten to thank "Lindum" for the correction of two blunders in my communication *re* loaded governor problem which appeared in your issue of December 30th. In the first, I had stupidly enough overlooked what is so plainly evident upon looking at the diagram, namely, that one half of the "additional centrifugal action of the balls" is expended in producing tension of the arms, and hence only the remaining half is available for producing tension of the links, so that the total centre load must be 36lb. and not 72lb. The diagram may still be drawn just as shown, remembering only that 36lb. is the total load, corresponding to both balls, whilst an amount of centrifugal force equal to that due to one ball is all that is available for lifting that 36lb.; the other half of the centrifugal force, or an amount equal to that of the other ball, being for tension of the arms. In the expression for centrifugal force the word "mass" should read "weight." This error crept in owing to my changing the form of the expression when it was partly written.—Yours truly, Graphic.

January 16th, 1888.

COLLAPSING PRESSURE OF TUBES.

To the Editor of "The Practical Engineer."

Sir,—There are probably many old boilers still in existence constructed at the time when exaggerated ideas as to the strength of their flues prevailed. These opinions were modified when Sir W. Fairbairn published his formula for the resistance of flues to collapse, but as even this often gives results in excess, as it is incorrect in principle, and as there may be boilers working at pressures that are dangerous, I venture to offer a formula I consider more accurate. Let t = thickness of flue plates in sixteenths of an inch, D = external diameter of flue in feet. Then P the collapsing pressure in pounds per square inch $= \frac{16\,t^2}{D^2}$ when the length of flue is seven times its diameter or more. When the length is less than seven diameters, the flue is stronger than one seven diameters long, in proportion as the length is reduced. The collapsing pressure in a cold water test might be one-fourth more, but not when the plates are heated and there is an end pressure on the flue, owing to its being expanded by heat more than the shell. This calculation should be made on the least thickness of the plates. As compared with their strength when new, the flues of old boilers may collapse with two-thirds, or even half of the pressure given by this formula, depending on the wear and deterioration in quality of the plates, and on other defects. The flues are supposed to be plain, lap-jointed and riveted, not flanged or fitted with rings, water pipes, or stays.—Yours truly, W. I. Ellis.

Manchester, January 16th.

THE TINWELL EXPLOSION.

To the Editor of "The Practical Engineer."

Sir,—Report No. 240, on the explosion of a Cornish boiler at Tinwell Mills, Rutlandshire, has now been issued. It appears to be another case of "age and maker unknown," which is not surprising after a glance at the sketch representing the construction. The preliminary inquiry was conducted by Mr. W. H. Woodthorpe, who in his report gives us very little information, but tells us the primary cause of the explosion was shortness of water. This theory, although doubtful, is likely to be accepted as correct, seeing that the glass water gauge was considerably lower than desirable, and it is just possible that water would be visible in the glass tube while the crown flue would be bare. Testing this boiler to "70lb. steam pressure" was in my opinion sheer madness, when there appears to have been no means of knowing whether the pressure gauge was correct or not. Actually the gauge was taken up uninjured, and on its being tested, it was found to be dangerously wrong, and showed 50lb. when there was 70lb. on boiler, and 60lb. when there was 115lb. on boiler. In my opinion the form of the flue had much to do with the explosion. There was a taper ring at mid-length, all the taper being in the top side, thus being favourable for straightening out or crumpling up, as the expansion or contraction influenced it. The form of flue, absence of fusible plug, incompetency and foolhardiness of the engineer, who appears to have been relied upon by a too-confiding owner, do not receive any comment from Mr. Woodthorpe, and were it not for the plates I. and II., the report would not be worth more than 1d.; still the charge is 9d. Will these reports ever be within the reach of the public? I am of opinion that if they were reduced to one-fourth the price, eight or ten times the number would be sold.—Yours, etc., Chalkline.

January 14th, 1888.

Charge of Cowardice.—Captain Nepean, R.N., and Lieutenant Tipping, R.N., Inspectors to the Royal National Lifeboat Institution, held an inquiry at Dunmore on Saturday into a charge of alleged cowardice against the coxswain and some of the crew of the local lifeboat, on the occasion of the loss of the American vessel Alfred D. Snow on the Waterford coast in the early part of the present month. Evidence was given to show that the coxswain refused to launch the boat, and when pressed to do so, tendered his resignation at a moment when the crew of the wrecked vessel were actually drowning. The court held that the coxswain had been guilty of cowardice, expressing belief that his conduct had a demoralising effect on the crew. Had the boat been launched in time there was nothing to prevent her saving the shipwrecked crew.

QUERIES AND REPLIES.

Dies for Shoe Rivets.—Could any reader inform me how the dies used for putting the screw-like marks on shoe rivets. are sunk. Any information on this matter would greatly oblige—E.B.

Answer.—The dies, aftor being fitted in their place, should be cramped face to face and drilled to the same size as the wire that is used. After being countersunk for the head, the teeth or threads are cut with a round nose chisel, the die being secured in a vice with the countersunk side facing the operator.—J. R. Aldred.

Forced Draught.—Can any of your readers inform me where or how I may get full information as to the results developed by the uso of forced draught in marine boilers; which system is used in H.M.'s Navy, and whether there is any reliable work or reference on forced draught?—Velocity.

Answer.—If "Velocity" will communicate with me I shall be pleased to give him all the information he requires upon the subject of forced draught, as I have had a considerable experience with same on board ships.—T. D. Bumstead, Cannock Chase Foundry, Hednesford, Staffordshire.

Copper Balls.—Could any reader oblige with information as to how the halves of copper balls (similar to those used for water ball-valves) are made. Is the copper pressed to shape between top and bottom dies, or is it spun or gradually worked into a corresponding half-mould, in a lathe or similar machine? I want to make some about 3in. diameter.—Sphere.

Signalling.—Will any reader give me the most approved method of signalling in long and steep inclines, and the advantages over the old wire and hammer system.—W.A.

Hopkinson's Safety Valve.—Could any reader give me a description of Hopkinson's dead weight safety valve, and show how to calculate the weight for different pressures. A sketch will oblige.—S.S.N.

Launch.—Could you or any of your readers inform me as to the thickness of steel plating used in the construction of a launch; the usual length and breadth of same, sizes of Frames, also the best method of constructing the kiel.—W.B.

Launch Building.—Will some reader inform an amateur as to the best method of making the lap joints of small steel launches watertight, also as to the best anti-corrosive paint, as the plates, $\frac{1}{16}$in. thick, are not to be galvanised. Is there any book published on launch building, giving details, &c.—(Scantlings), J.D.

Electrical Resistance.—What is the simplest apparatus for measuring the electrical resistance of a metal or a liquid?—J.D.

The Odontograph.—What work contains the best practical description of the odontograph?—J.E.H.

Enamelling Iron.—Can any of your readers give me the names of firms who enamel small iron or steel articles, such as guide bars and mouse-traps used in silk machinery.—Kiel.

Guide to the Indicator.—What is the price, and who are the publishers of "Wood's Comprehensive Guide to the Steam Engine Indicator?"—R.W.

Engines of the Etruria.—Could any reader supply me with the leading dimensions of the engines of the *Etruria*, or *Ormuz*.

Marine Problems.—(1) Suppose a marine engine to be developing the full horse power; will it, when the steamer is making its way up a river, give the same number of revolutions as when the steamer is going down the river, neglecting the friction of the air due to the varying speeds of the vessel in the two cases? (2) A steam ferry boat requires to cross a river in a straight line, but owing to the current the steamer has to be headed partly up stream all the way across, and thus it crosses in a straight line, but in a sideway position. Will the pressure of the current on the vessel be greater or less on the upside than on the down side?—R J.G.

TO CORRESPONDENTS,

P.C.—Price of volume is 6s. 6d., cases for binding 2s. Back numbers can be supplied at 1½d. each, post free.

W.C.B.—Muntz's Metal Co., Trench Walls, near Birmingham, or the Birmingham Battery and Metal Co., Birmingham, will supply you with solid drawn brass tubing.

X.Y.Z. sends an anonymous contribution; will the writer send his name and address, and also state whether it is a table or a diagram that he is referring to.

Reducing Valve.—Descriptions of two reducing valves will be found in *Thh Practical Engineer* for April 1st, 1887, and Sept. 2nd. 1887, to which you would do well to refer.

R.M.—There is an error in A.G.K's reply which was overlooked at the time; the writer evidently intends that tho hand wheel is keyed to the spindle while the worm wheel is loose, when, of course, to feed by power the wing nut is tightened, and to feed by hand it is slackened.

Constant Reader—Your letter is not quite clear; do you want to know how to construct the hyperbolic curve. The graphic diagrams that have appeared in the journal from time to time have had no reference to the indicator diagrams.

J.D.—We have not worked out a diagram for the thickness of cylinder beyond the dimensions shewn in the figure in our issue of last week, but it would be easy to do so for pressures up to say 150lbs, and diameter 90in.; we think, however, that there is no reliable data extant that would warrant a rule for cylinders and pressures as high as mentioned in your letter.

J.D.—The proportioning of suction and delivery pipes is a matter that varies with circumstances, but it is usual to make the suction pipe larger than the delivery pipe, because friction in the former is overcome solely by the pressure of the atmosphere, and hence it is desirable to minimise the friction. The suction pipe should not be less than half the area of the pump barrel, and the delivery from a third to a half. When the pipes are long those proportions are exceeded.

An Enquirer.—You are confusing bending action on the arm with the weight or reaction of the fulcrum, which are totally distinct and separate forces and quite independent of each other. The bending moment *on* the arm *at* the point of support, (not bending moment on the fulcrum) is equal to the weight multiplied into the distance from the point of support or fulcrum, neglecting the weight of the arm, but this has no connection with the stress on, or reaction of, the fulcrum, which is simply the dead weight of the apparatus and load. In your example the weight on one side of fulcrum is 10lb., and distance 1ft., and on the other side the weight is 1lb. and distance 10ft., of course, in order to balance,. The bending moment on tho arm at the fulcrum is 10 foot-lbs., but the weight on the fulcrum is 11lb. plus the weight of the arm. If the arm is lengthened to 20ft., still retaining the same weight and position of centre of gravity, then there would only be required ½lb. at the long end to balance the 10lb at the short end, but the stress on the fulcrum would now be less than before, viz., 10½lb. plus the weight of the arm. If a man holds a weight on his back or in his stretched out hand, he will weigh precisely the same on any machine, but all the while the bending moment on his shoulder in the latter position might be almost greater than he could bear.

MISCELLANEA.

Shipbuilding.—The improvement in shipbuilding is now manifest from the Thames to the Clyde. In November the Society of Boiler Makers and Iron Shipbuilders paid to members out of work and otherwise needing relief £910 per week. In December the sum fell to £790 per week. There are still more than 4,000 members in receipt of allowance.

The Madras Railway Staff.—The Board of Directors of the Madras Railway Company in London have, it is said, determined that the post of Chief Engineer of the Company is to be a five-years' appointment, and the salary is to be reduced after the retirement of Mr. W. R. Robinson, who is at present on leave in England. The strength of the Engineering Staff is also to undergo revision.

Accidents from Telegraph Wires.—At Marion, Idaho (U.S.), one of the street arches was accidentally blown down, the wires dropped, and a couple of horses becoming entangled in them were killed by the electric current. This forms another argument in favour of placing electric light conductors underground, as it was a mere chance that human life was not sacrificed instead of the unfortunate horses.

Electric Light Statistics.—It is stated that official statistics show the number of electric lights in Germany to be not less than 15,000 arc and 170,000 incandescent lamps, with 4,000 dynamos. The estimated power used for all these lamps is about 30,000 indicated horse-power. One single firm in Berlin manufactures 2,000 incandescent lamps daily, and intends to increase the facilities so as to produce 5,000 lights of all sorts daily.

Novel Invention.—Here is another American invention. No more looking through keyholes. A keyhole guard has been patented by Mr. Alfred J. Urlin, of Missoula, Montana Ter. This invention provides a slide block preventing persons seeing through the keyhole, or the admission of cold air, etc., and also preventing the key from being turned from the outside, or from falling out of the lock.—*Invention*.

Accident in the Severn Tunnel.—An Aberdare goods train, laden chiefly with coal, parted in the middle through the snapping of the couplings whilst in the tunnel. The latter part of the train was left behind for some distance, but it gained speed in the decline of the tunnel, at the bottom of which it dashed into the former portion of the train. Several wagons were smashed, and these, with the coal, caused a blockage on both lines of rails. No person was injured.

Celluloid for Sheathing Ships.—Among the various uses of celluloid, it would appear (according to the *Annales Industrielles*) to be a suitable sheathing for ships in place of copper. A French Company now undertakes to supply the substance for this at 9 francs per surface-metre and per millimetre of thickness. The colour of the substance is indestructible; the thickness may be reduced to 0·0003 metre; and the qualities of elasticity, solidity, impermeability, resistance to chemical action, etc., are all in favour of this use of celluloid.

Telephone Communication.—The *Electrician* announces that an agreement has been arrived at between the United and the National Telephone Companies, whereby the Metropolis will shortly be placed within speaking distance of the Midland districts, and ultimately also with the North of England. A heavy copper line will at once be laid to Coventry, and from there it is intended to fork to the left to Birmingham, and thence to Liverpool and Manchester, and to the right to Nottingham, Sheffield, and Leeds. The details are not yet, however, fully decided upon; "but it may be anticipated that the line will be open to Birmingham within a few months from the present time."

Dundee Mechanical Society.—At the last meeting of this society, Mr. Andrew L. Peacock read a paper on the use of brass in mechanical engineering. He explained the different metals under the heading of bronzes and brasses, and sub-divided them into the compositions used by engineers for special purposes, dwelling particularly on the production of phosphor and manganese bronzes. The use of anti-friction alloys was referred to, and it was stated that unless carefully watched they were apt to give trouble in certain cases, such as locomotives and marine engines. In the discussion which followed the opinion was expressed that the explosion which took place on board the Elbe was due to defective workmanship in brazing the copper pipe which burst.

The Royal Agricultural Society's Jubilee Show.—An influential meeting of the residents of Windsor and the neighbourhood was held on Saturday afternoon at the Windsor Guildhall with reference to the proposed holding of the Royal Agricultural Society's Jubilee Show in the Great Park next year. The chairman stated that the Queen, Prince Christian, Lord Wantage, the Duke of Westminster, the Earl of Coventry, and many others had accorded their support to the project, and that £1,500 had been promised towards the £2,000 which had to be guaranteed by the 30th inst. The last show at Windsor was held in 1851, under the patronage of the late Prince Consort, and he hoped that of 1889 would prove as great a success.

Horse-shoeing Competition at Nottingham.—An interesting feature of the Royal Show at Nottingham, next July, will be the horse-shoeing competition, in which the shoeing smiths of the counties of Derby, Leicester, Lincoln, Northampton, Nottingham, and Rutland, will compete for substantial prizes offered by the Royal and Lincolnshire Agricultural Societies. There will be two classes—viz., Hunters and Agricultural horses, and in each there will be six prizes, varying from £6 to £1, for the smiths who exhibit the greatest skill. To any of these prizes, which may be won by a shoeing-smith residing in the County of Lincoln, the Lincolnshire Society will add a further prize of half the amount. Each competitor will be required to make a fore and hind shoe out of new iron provided by the society, to take off the fore shoe and put the new one on. The time occupied will be taken, and will be considered by the judges in making their awards. In addition to the prizes, the society's certificate of efficiency will be given to the prize winners and commended competitors. The entries for this competition will close on June 1st next.

Agricultural Machinery in Russia. — The Austro-Hungarian Consul at Kieff, reporting on the recent agricultural exhibition at Kharkoff, says that the most interesting and important section was that containing agricultural machinery. Foreign firms were well represented, yet it was impossible not to perceive that the Russian manufacturers held their own in all classes, from the simplest iron plough, to the most complicated threshing machines. It should be noted, however, that the articles showed more solid and careful work than is usual in the factories of Russia. In these respects, as a rule, foreign machinery is far superior to Russian in spite of the clever imitations by Russian makers of the more complicated machines. This inferiority is due in a great measure to the use of inferior steel, iron, and wood. The maintenance of this superiority is therefore essential for the increase of the sale of foreign agricultural machinery in Russia, and will produce this result in spite of the increasing development of the native manufacture and the protective policy of the Government. Foreign competition is aided also in many cases by the high prices of Russian productions, the manufacturers trusting largely to the protective tariffs against foreign rivals.

Japanese Government Contracts.—The last report of the American Minister to Japan on the trade of that country refers to the favouritism shown in giving Government contracts for public works. Mr. Hubbard says :—" While I have asked earnestly for my countrymen the sheer privilege, in common justice and equity, to compete for such Government contracts (such as railways and other public works, upon which Japan is now entering largely), and while I have been told that an equal showing would be given to Americans, it has not been done, and the largest and most profitable contracts of the Government proper, have been awarded to German, English, and French people. Nevertheless, the people of Japan trade with us by many millions more than with any other nation. We consume nearly all her tea and over one-third of all her silk, on which no duty is paid at our ports. . . . . Other things being equal, therefore, on the score of equal inducements as to prices and qualities, we may unfortunately have cause hereafter to complain that the reciprocity in trade, even when the conditions are the same, is ignored, while giving fresh assurances on paper of our long-continued and cordial friendly relations." Mr. Hubbard thus involuntarily acknowledges that the charge made by British merchants in Japan that foreign diplomatists intefere with the Government to obtain contracts for their countrymen is, so far at least as he is concerned, perfectly correct.

Bad Workmanship.—A firm of shipbuildres are being sued by the Admiralty for bad workmanship in a vessel fitted out in their yard. The sum claimed as damages is £3,000.

SELECTED PATENTS.

APPLICATIONS FOR LETTERS PATENTS.

January 6th.

223 Rotary Knife-cleaning Machine, T. Wilkins, Clerkenwell.
224 Incandescent Lamps, E. Böhm, London.
225 Electric Battery for Miners' Lamps, H. Abbott and J. Douglas.
226 Expansive Valve Gearing, J, Williams. London.
228 Mechanism for Stopping-engines, W. Holland, Tamworth.
229 Cleaning and Polishing Steel Wire, J. Shaw, S. Shaw, and T Shaw, Halifax.
232 Weighing Apparatus, J. C. Watkins, M. Fidler, and J. Fidler, Bradford.
237 Oil-feeding Apparatus Bearings, G. Thomson, Manchester.
238 Equilibrium Valve, A. Roberts, Halifax.
239 Safety Gas Burner, F, T. Reid, E. Seage, and F. Seage, Exeter.
243 Nails, R. Sunyé, and V. L. A. Blumberg,
248 Rock Boring Machinery, J. O. O'Brian, Manchester. (C. Bomet, France
249 Electric Meters, J. T. Roe, Maida Vale
250 Nuts, E W, Hughes, and S. A. Letts, Surrey.
252 Hydraulic Lifts, W. R. Green, London.
253 Engine Counters. R. McInnes and H. A. Morriss. Glasgow.
254 Hydraulic Tramway Locomotive, W. P. O'Neill. London,
256 High Pressure Tap, J, C. Sawer, London.
258 Combination Lock and Latch, C. R. Heckford, London.
263 Couplings for Railway Vehicles, C. Lock. London.
270 Hydrocarbon Engines, W. D. Priestman, and S. Priestman, London
274 Apparatus for Filing Teeth. D. R. Eden. London.
275 Automatic Brake Mechanism, C. D. Abel, London. (G. Westinghouse, jun., United States.)
280 Straining and Splicing Wire, G B, Williamson, London. (H. Hughes, New Zealand.

January 4th.

281 Compressed Air Motors, J. E. Rogers, Smethwick.
291 Punch and Die, W. Allan and J. McBlain, Wallsend-on-Tyne.
292 Railway Signalling, J. H, da Fonseca, Stockport,
223 Dynamo-electric Machine, T. Parker, Manchester.
295 Electric Meter, T. Parker, Manchester.
296 Electric Switches, T. Parker, Manchester.
301 Washing and Separating Machinery, J. Ramsay, London.
306 Railway Buffers, T. H. Heard, Sheffield.
309 Rotative Fans for Forced Draught, S. H, Holland, Chatham.
311 Air Pumps, E. H. Trelease, Clapham.
315 Closed Ash-pits, R. W. Hewett, Birmingham.
319 Testing Pressure Gauges, C. S. Mallettt, E. A. Hoad and J. Jackson, Chancery Lane.
321 Atmospheric Hammer, W, Hassel, London.
325 Manufacure of Tubes. W. R Comings, Middlesex.
327 Belt Fastener, H. Bell, and T. H. Carr, London.

January 9th.

339 Furnace Tube Cleaner, R. Falconer, North Shields.
340 Anchors, F. D. Taylor, Birmingham.
342 Safety-guards for Tram-engines, E. Considere, Birmingham
344 Anchors. J. Niven, Liverpool.
352 Raising Sunken Ships, G. Drake, London.
355 Connecting Tubes or Pipes, A. Vigouroux and A. F. Drivet, London.
361 Condensers, L. Sellner, London.
365 Ventilating Petroleum Tanks, J. Price, London.
366 Electric Arc Lamps, C. D. Abel, London. (The Firm of Siemens and Halske. Germany.)

January 10th.

367 Steam Engines, E. R. Royston, Manchester.
386 Wood Planing Tools, W. P. Thompson. Liverpool. (D. Brown, Australia,)
395 Supplying Lubricants Under Pressure, T. H. Taylor, Manchester
401 Treatment of Low Steel. H. A. Harvey. London.
403 Circular Saw, W. Sanday, Holborn,
404 Cramp or Rack and Jaws, W. Sanday, Holborn.
408 Stern-posts, J. H. Laidman, London.
414 Quadruple Expansion Engine, G. Kingdon, F. C. Simpson, and F. Strickland, London.
417 Burning Lime, &c,, J. H. Darby, Middlesex,
426 Revolving Shuttles, R. Haddan, London. (F, Hensel, Germany).
428 Forge Bellows, W. Allday and E. Allday, Middlesex.

January 11th.

431 Motors, H. J. C, Keymer, Suffolk.
433 Apparatus for Facing Nuts, R Taylor, Manchester.
442 Flues and Dampers, J. Taylor and E. Taylor, Rochdale.
443 Candle Moulding Machines, H. A. Biertumpfel and E. J. Biertumpfel, London.
457 Double Hand Saw, T. Forsaith, London
461 Turbine Governors, C. L. Hett, Paddington.
474 Vessels Propelled by Screws, T. W. Scott, London.
478 Endless Traction Rope Systems, J. A. Westerman, London.

January 12th

507 Signal Telegraph, E. Berg, Berlin.
510 Pocket Screwdriver, J. P. Gorton, Weston-super-Mare.
511 Ventilators for Exhausting, J. Howorth, Manchester.
512 Petroleum Engins, T. Sington, Manchester.
514 Automatic Weighing Machines, A. Lafarque, Middlesex.
517 Calculating Machines, G. F. Pickering, London.
518 Oil Lamps, C. Asbury, London.
523 Furnaces, A, Orcel, London
529 Mercurial Air Pumps, J. Y. Johnson, Middlesex, (H. J. Doerr and Theodore Mace. United States.)

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EDITORIAL NOTICES.

All communications for the Editor of this Journal should be addressed to the Manchester Office, 3, Grosvenor Chambers, Deansgate, Manchester.

Communications intended for insertion in the current week's issue should reach us not later than Tuesday Evening.

We cannot undertake to return rejected manuscripts or drawings unless accompanied by a stamped and directed envelope.

Contributors are requested to write on one side only of the paper. Sketches should be sent on separate sheets.

TO ADVERTISERS.

Advertisements intended for insertion in the current issue should reach us on Wednesday morning at the latest.

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NOTICE TO NEWSAGENTS AND SUBSCRIBERS.

Numerous complaints having been made to us by Subscribers of the difficulty they experience in obtaining copies of the *Practical Engineer* in certain districts, we have to state that the Journal can be obtained by any Newsagent through the ordinary Trade channels, and no difficulty should therefore exist in obtaining copies by order of any Newsagent.

For the information of the Trade, we may state that copies can be obtained from either of our Offices in London or Manchester, or from any of the following wholesale houses, who are also supplied with Contents Bills for the use of the Trade:—

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W. THOMPSON & SONS, St. Petersgate, Stockport.
&c., &c., &c.

NOTICE.

Back Numbers.—*As we have received several letters from correspondents who have found a difficulty in obtaining* BACK NUMBERS *of the* Practical Engineer, *we have to state that all the back numbers are still in print, and can be obtained from our office on receipt of stamps to cover cost and postage.* CASES *for* BINDING *the* Practical Engineer *can be obtained from the publishers, price 2s.,* Post Free. Volume I., *bound in cloth, containing the numbers from March to December, 1887, can also be had, price 6s. 6d.,* Carriage Free.

FIRST "FORMAL INVESTIGATION" UNDER THE BOILER EXPLOSIONS ACT, 1882.

The first formal inquiry, such as is provided for in Section 6 of the above Act, has been held and closed. In another column will be found a summary of the evidence laid before the Commissioners appointed by the Board of Trade to enquire into the "causes and circumstances attending the explosion" of a Rastrick boiler, at the works of Messrs. Brown and Freer, Brockmoor Iron Works, Brierley Hill, near Dudley, in October last, by which seven persons were killed and a number of others injured. The Commissioners will report the result of their inquiry to the Board of Trade, and in due course (perhaps in about six months), a Board of Trade report will be issued giving the result of the investigation, which can porbably be obtained by the general public at a cost of some three or four shillings, or perhaps more.

Considerable interest attaches to this inquiry, partly on account of its being the first yet held under the Act, and partly because of the remarkable circumstances attending the explosion. The boiler was one of peculiar type, albeit one which is regarded with great favour in the Black Country, and in most iron-producing districts. It was insured by an old-established and well-known boiler insurance company, and it had been examined and pronounced in safe working order by an officer of the company only a few days prior to the explosion, which occurred shortly after the boiler had been set to work after cleaning. Hence the proceedings will have been followed with no little curiosity by steam users, and by most of those who are interested in the safe working of steam boilers. After a careful study of the evidence, and the manner in which the case was laid before the Commissioners, it seems to us there will be a feeling on the part of most of those who have had any considerable acquaintance with the circumstances most frequently attending boiler explosions, that the case has been got up in a somewhat one-sided manner, and in such a way as to lead to the adoption by the Court of certain conclusions already arrived at by the officials of the Board of Trade, or of those who conducted the preliminary inquiry. For, taking the evidence adduced, and the manner in which the different points were afterwards put before the Commissioners by Mr. Howard Smith, the barrister who appeared on behalf of the Board of Trade, it may be regarded as a foregone conclusion that the Commissioners will report that the explosion was due to a hidden flaw or seam-rip, which could not be detected by inspection, and will recommend amongst other things that brickwork should be more frequently removed for thorough inspection; that steam generators of the Rastrick type are not safe in works where large numbers of men are employed, and that boilers should be regularly subjected to hydraulic test, for which the officials of the Board of Trade have always shown a remarkable weakness.

A great deal might be written on each of these points, but, seeing that the result we have foreshadowed above is so far mere conjecture, we will leave these for subsequent consideration. Our more immediate object at present is to draw attention to a few most important facts and circumstances upon which the evidence is practically unanimous and conclusive, and which, to most boiler experts, will appear of quite as much importance as the theories which those who have conducted the case for the Board of Trade have laid so much stress upon. The adoption of a wrong conclusion, such as attributing a disastrous explosion to a hidden flaw, which could not well be detected, except by taking extraordinary means—applying hydraulic tests, etc.—may have most mischievous consequences in diverting attention from circumstances and conditions of real danger, which may lead, and, indeed, have led, in too many instances to the most lamentable results.

In the present instance, for example, when we read the evidence tendered before the Coroner, as well as before the Board of Trade Commissioners, we find conditions existing which have time after time led to the most serious explosions, and which, if only fully established, are in themselves quite sufficient to account for the explosion in question without having to resort to the theory of "hidden flaws," "defective type of boiler," or any other surmise.

For we have it clearly established by every witness called, that the safety valve was in most deplorable condition—long rods hung down from the safety valve levers, giving every facility for overloading, and that weights were continually being added to and taken from, the safety valve lever. There was no pressure gauge on the boiler, and it appears more than probable that the stop valve was closed at the time of the explosion. Granted the above conditions, and the explosion is at once accounted for by overpressure, apart from any defects in the boiler whatever, and this is the conclusion admittedly first arrived at by the Board of Trade surveyor, by Mr. E. B. Marten, the chief engineer of the Midland Boiler Assurance Company, who insured the boiler, and by other experienced engineers, who were not called upon to give evidence. In his evidence before the coroner, the superintendent engineer at the works stated that on examining the stop valve after the explosion, he found the spindle very much bent, and a "little liberty"—about $\frac{3}{16}$ths of an inch—between the valve and face, but after straightening the spindle, the distance between the valve and face was about $\frac{1}{16}$th of an inch only. This, we submit, means that the valve was practically closed. In his evidence before the Commissioners, the Board of Trade surveyor states that the valve was within $\frac{3}{16}$ths of being closed, and the spindle and columns of the crossbars were bent, and there was $\frac{5}{16}$ths "slack" in the pin securing the valve to the spindle, so that the valve acted like a feed back-pressure valve. When it is considered that the boiler had just been started after cleaning, and the man in charge might have forgotten to open the valve to connect it with the other boilers (though he does not admit this), there appears all the more likelihood of the explosion having resulted from overpressure consequent on the stop valve being closed, and the admittedly defective safety valve being jammed fast and inoperative, or loaded (owing to its defective and leaky condition) to a dangerous pressure, nothing being more common amongst ignorant attendants than to add weights to prevent a leaky safety valve from blowing.

Not having had the opportunity of making personal investigation into the circumstances of the explosion, it would, of course, be presumptuous on our part to positively assert that overpressure was the real cause; but there are well-known engineers of large experience in the investigation of these disasters who have examined the exploded boiler and seen the defective safety valve, etc., who hold this view; and we think on a careful perusal of the whole of the evidence that most boiler experts would be more inclined to take the same view than to accept the theory that a seam rip could exist sufficiently severe to cause explosion at a comparatively low pressure, and which would give no indications of leakage when the boiler was at work.

Although it is true that the boiler insurance company's chief engineer modified his evidence somewhat before the Board of Trade Commissioners, and seemed more inclined to the seam-rip theory than to the over-pressure theory, than when he gave his evidence at the Coroner's inquest, yet there need be nothing surprising about this when it is considered that the over-pressure theory requires not only that the safety valve should have been in defective condition, which there is no doubt about, but that it should have been jammed fast in its seat, or else overloaded.

This valve, singularly enough, was not examined at the time of the thorough inspection a few days prior to the explosion, and its condition was consequently not pointed out to the firm. In justice to the inspector, however, who is a man of large experience, it should be stated that he maintained before the Board of Trade Commissioners the opinion he expressed at the Coroner's inquest, that the explosion was due to over-pressure, in consequence of the stop-valve having been closed.

Wherever blame attaches, and censure is likely to be incurred, or perhaps punishment, "hidden flaws," and "undetectable defects" are very convenient, just as is a verdict of "accidental death," for diverting attention from the real cause of a disaster such as the Dudley explosion; but we think it will be to the last degree unfortunate in the public interest if, assuming that this disaster really arose from over-pressure, due to conditions which should not exist, and could be easily remedied, it should be published to the world, with all the authority of the Board of Trade, that a "hidden flaw" was the cause, and that this could only have been detected by taking extraordinary measures, such as would entail the greatest inconvenience to the steam user to carry out.

FRICTION AND LUBRICATION.

The proper selection of a lubricant for any given class of work is a thing, we fear, that is much neglected amongst machinists, and users of power generally, and this arises no doubt from the imperfect knowledge of the excessive loss of energy or power that takes place when a journal is inadequately or improperly lubricated; or, on the other hand, when the lubricant is an unsuitable one for the work it has to do. To take an extreme case, no one would think of lubricating a watch with common sperm oil, or using the finest machine oil for a cart wheel; but in the vast number of operations conducted by machinery, there are cases where it would be possible to make errors in lubricating almost as glaring as those indicated, without, perhaps, being detected by many who pride themselves on possessing some knowledge on this subject. In a publication by Professor Thurston, of America, entitled "Friction and Lost Work in Machinery and Mill Work," there is a good deal of very interesting and instructive matter, and the author speaks in no uncertain terms of the evil of attaching too much importance to the price of a lubricant, and too little to the quality of it. He says, "All lubricants should be purchased with a careful regard to the value, rather than by reference mainly to their cost. . . . Unguents of low grade cause losses direct and indirect, which are out of all proportion to their low cost. And again, in some cases using crude or black petroleum, the cost of wear is but little less than that of power. . . It is frequently the fact that one can better afford to use the highest priced article, than to take those of lower value as a gift. In fact the importance of reduction in the cost of the unguent is usually absolutely insignificant in comparison with securing the best possible lubrication."

These extracts have been given to show what a great authority has to say on the question of securing the best lubrication; and it is evident that the cost of the lubricant itself, in his opinion, is of very little consequence, and that the real value as a lubricant should always determine whether it is worth having or not. We have had considerable experience of unguents and their use, and can confidently support all that Professor Thurston says. We could mention, amongst others, a case where the change of the lubricant used throughout a mill, so far reduced the friction that a considerable addition of machinery was possible, without putting more weight on the engine; and in some instances a change from a good to a bad lubricant has been sufficient almost to stop the already overworked engine.

Animal and vegetable oils are not the most desirable kinds of lubricant for machinery, because of their tendency to dry up under the action of the atmosphere, and leave a sticky gum on the bearing, which, as may be supposed, is very detrimental to easy turning, and in some cases is very hard to remove; further, these oils often attack the metal itself with very injurious consequences. A better lubricant is the mineral oil, of which there are several varieties in the market, Russian, American, and shale, and while admitting that there are faults to be found with some of these, yet we believe they are superior to animal or vegetable oils for the purposes of lubrication. The objections just referred to are caused by the presence of acids used to clarify and deodorize them, and by their distillation having been effected by dry heat, which is liable to turn the oil to a tar, and destroy its lubricating properties. But where the volatile oils are driven off, say by superheated steam, and where no acid is used in refining them, these oils are undoubtedly the best that can be used. It is usual to evaporate the volatile oils by the superheated steam method at a temperature of from 1,200° to 1,400° F., after which the bitumen and solid impurities are removed by filtration through animal charcoal. This system is, we believe, adopted by Messrs. Boult Bros., Liverpool, in the manufacture of "valvoline" oils, which have attained a deservedly wide reputation, possessing as they do a pure lubricating body, and being free from the objections pointed out in this article.

COPPER.

The extraordinary rise in the price of copper that took place in the two months of November and December, has formed one of the chief topics in business circles and the question has evidently an interest for the general public as well. A sudden rise from about £40 per ton to £85 in the price of this metal, has, we think, never been equalled in the history of the trade. The lower figure was, as everyone knows, an unremunerative one, and many companies have been ruined by the low current rates that have existed for so long. Notwithstanding the extraordinary inflation of the price of copper, we are hopeful that it will be maintained for some years to come, at not less than about £80 in the natural course of business, which would conduce to a much more healthy state of trade in copper than has existed for a considerable time. The increased cost of copper wire will naturally curtail its consumption in the telegraph service, where it was coming into very general use, and so far will act prejudicially on the consumption, but this item forms a small fraction of the total output, and will have little effect on prices.

THE BOILER EXPLOSIONS ACT.

From one or two little circumstances that have recently occurred, it would appear to be the intention of the Board of Trade to administer the Boiler Explosions Act with a little more rigour than has hitherto been the case. From a public notice which appeared in the columns of our London contemporaries on Friday last, it would seem that the department also intend in future to insist on a more stringent observance of section 5, relating to the notice of a boiler explosion, which it is stipulated shall be sent by the owner or user within twenty-four hours of its occurrence. The maximum penalty which may be inflicted upon a boiler owner for non-compliance with this section is £20. We believe, however, it is not customary to insist too rigidly upon the enforcement of the penalty clauses of a new act of parliament until it has been allowed to run for some time, and there is reasonable ground for believing that those affected by its operations are fairly well acquainted with its provisions. The Board of Trade apparently think that, after nearly six years' working, boiler owners can scarcely plead ignorance of the existence of the Boiler Explosions Act, and the notice to which we have referred states that on December 27th the owner of a boiler, which exploded on the 28th of November, was charged at the petty sessions, Caerphilly, with having neglected to send notice of the occurrence within twenty-four hours thereafter to the Board of Trade, and fined in a mitigated penalty of twenty shillings; while the notice adds that in all future offences of a similar character, the department will press for the infliction of the full penalty of twenty pounds.

LITERATURE.

Turning Lathes. Edited by James Lukin, B.A. Pp. 160. London: E. and F. N. Spon.

This is one more to the many books on the art of turning, from Holtzapffel's and Evans' downwards, but we think it will nevertheless be useful to many an amateur or apprentice, for whose benefit it has specially been written. The author does not presuppose any technical knowledge whatever in the reader, but begins by describing and naming the various parts and attachments of a lathe, so that a schoolboy can pick up the book and work his way through it without any difficulty. The illustrations are very numerous and well executed.

THE "EJECTOR" DRAINAGE SYSTEM.

Of late years there has been introduced a system of drainage which dispenses entirely with the use of pumps for raising the sewage to the higher levels. How far this system has claims on the score of economy is a matter for practical experience, but a short explanation of its principles will enable the reader to judge of its efficiency.

By gravitation the sewage matter is collected in an enclosed receptacle called an "Ejector," in which it rises to its full height, through an inlet at the bottom, fitted with a ball valve. The air above the surface of the rising fluid is expelled through an open valve, which remains open until the fluid comes in contact with the edges of an inverted cup, fixed upon a rod having a vertical motion. The air within the cup is now enclosed, and as the fluid rises still higher, it carries up the rod, which, by connection with the air valves, closes the one before mentioned, and opens another in direct communication with storage reservoirs, into which air has been pumped to a pressure of from 20 to 25lbs. per square inch. This power acts as a piston on the surface, driving the fluid through an exit valve, similar to the inlet valve, up to the higher level. When the "Ejector" is exhausted, another inverted cup, placed near the bottom, and on the same rod as the upper one, is now separated from the fluid, and the combined weight of the two cups, together with that of the rod, causes them to drop, and in so doing they reverse the air valves, and the process is then repeated.

The working of the air-valves depends upon the combined weight or lifting power of the two cups when out of water or under it, and it is so arranged that when the rod is raised or depressed the full force of both is required to be exerted in the opposite direction to alter its position, and consequently that of the valves. The ratio of the buoyancy of the cups to their weight, added to that of the rod connecting them, is finely adjusted by the use of a weighted lever. The cups are, of course, designed to work with a fluid of low specific gravity, and of such cubical contents that they shall exert considerably more upward pressure than is sufficient to work the air-valves. The sewage inlet and outlet valves are simply cast-iron spheres about 12″ in diameter, sometimes covered with rubber, resting in seats, where they are held by the back pressure.

Several "Ejectors" may be used in such a system, all being supplied from one air-pumping station. This system has been at work for some years at Eastbourne, in Sussex, where the storage reservoirs measure about 14 to 16 feet long, and about 8 feet diameter, one being employed to each "Ejector." In case of a flood the pressure in the reservoirs can be raised until the sewage is driven out into the sea or river, though the water level be above that of the discharge pipe.

BIRMINGHAM CABLE TRAMWAY.

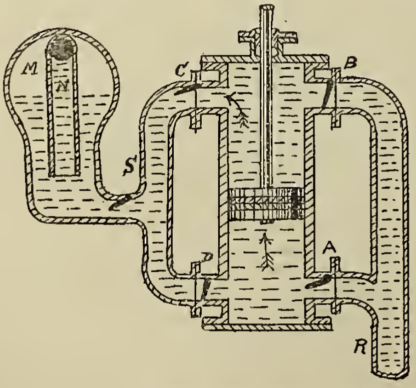
The first trial trip on the Birmingham cable tramway between Colmore-row and Hockley was made at an early hour on Sunday morning, and was accomplished without a hitch, though it embraces curves and dips of more than ordinary difficulty. An inspection of the lines, the engine station, and the cars will probably be made in the course of a day or two by Major Hutchinson on behalf of the Board of Trade, and the long expected cable service will thereafter at once begin running. The cable was run with a tension of no more than 11·4 tons. The cars are of comfortable construction. Each of them will carry 40 passengers, 20 inside and 20 outside, and it is contemplated to run a three-minute service, which may be reduced to a five-minute one if the traffic does not justify it. Outside the cars are "garden seats," which face the direction in which the car travels. Oil gas stored in reservoirs beneath the inside seats is used to light the cars, and they are provided with curtains which may be drawn in sunny weather. During the present week, the drivers who have been in training at Highgate Hill, London, will be placed in charge of their cars, and will make a number of journeys, so that they may become well acquainted with the particulars of the route.

APPLIED MECHANICS.

ELEMENTARY STAGE.

12. Explain the use of an air vessel in connection with a force pump. Sketch a section through a double-acting force pump, showing the valves and the connection of the pump with the air vessel, and explain the action of the pump.

The air vessel M in sketch is used to give a continuous flow of water. As the water is pumped into it through the valve S the air in the upper part is compressed, and the water is forced through the delivery pipe N; when the piston stops (or is on the return stroke in a single-acting pump) the valve S closes, and the compressed air in M forces the water through N, causing a continuous flow. The double-acting pump has four openings into it, each having a valve, all the valves open one way; as the piston rises the valves A and C open, B and D close, the water is drawn up the pipe R into the cylinder, while the water above the piston goes through the valve C into the air vessel M, and is forced out through the pipe N; when the piston descends, the valves C and A close, B and D open and force the water as before into N, thus keeping up a continuous discharge.—G.W.W., Manchester.

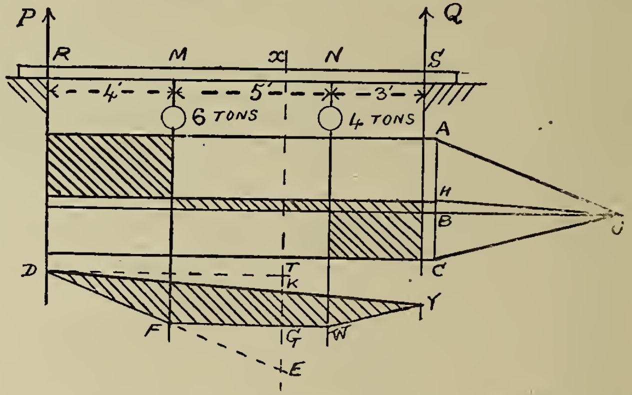


[Good replies from A. G. K., Wm. Platt, etc.]

ADVANCED STAGE.

30. Draw the bending moment and the shearing stress diagrams for a beam 12ft. long, supported at both ends, and loaded with weights of four and six tons at distances of three and eight feet respectively from one end of the beam. Explain fully the mode of arriving at these diagrams.

R S is the beam with the given loads at M N, through points R, M, N, and S, draw lines perpendicular to R, S, take A B and B C to scale to represent loads of 6 and 4 tons at M and N respectively, draw B O perpendicular to A C, take any point O in B O and join A O, C O; draw D F parallel to A O, F W to B O, and W Y to C O, join D Y, then D W Y F is the bending moment diagram; from O draw O H parallel to Y D, then A H and H C represent the reactions P and Q; through A, H, B, and C draw lines parallel to R S, and the shaded area so formed is the shearing stress diagram; from R to M the shearing stress = P .·. = A H; from M to N = 6 — 4 = 2 tons .·. = H B; from N to S = Q .·. = H C, which is represented by the diagram; at M the shearing force changes sign. Take any point x in the beam, then the bending moment at x = P × Rx — 6 × Mx; the triangles D E K, A H O are similar .·. $\frac{AH}{BO} = \frac{KE}{DT}$.·. A H × D T = K E × B O; the triangles F E G, A B O, are similar .·. $\frac{AB}{BO} = \frac{GE}{FG}$.·. A B × F G = B O × G E; .·. A H × D T — A B × F G = B O [K E — G E] = B O × K G; .·. the bending moment at x = B O × K G. The beam is drawn to a scale of 1in. = 6ft., the loads to a scale of $\frac{1}{16}$in. = 1 ton; B O = 1in. .·. B O measured to the same scale as the beam = 6ft. .·. bending moment scale $\frac{1}{16}$in. = 1 ton × B O = 1 ton × 6ft. .·. 1in. = 96ft. tons.—G.W.W., Manchester.



DRILLING HOLES.*

Precise accuracy in drilling and boring holes is no mean part of the machinist's business, and in certain kinds of work requires more care and skill than any other operation.

In many shops the drilling-machines are regularly abused, so that machines which are good to start with are soon rendered unfit for good work. If a machine which is intended for fine work comes into a shop, it should first be provided with a centre fitted to its spindle, and turned true in its place; if this is done it is only necessary to mark the centre of any hole which is to be drilled or bored; set the centre mark directly under the point of the spindle centre, fasten the work and proceed.

Whether the work is heavy or not, if considerable accuracy is required, it may be secured by making small centre marks, setting the work in position by the spindle centre, and using a short boring-bar for finishing the hole.

One or other of two conditions usually govern the location of holes in a piece of work. Either they must be placed at some given distance from other holes or working points, this distance being determined by direct linear measurement, or they must duplicate some piece of work already done.

Taking the case of holes, the distance between which is to be determined by measurement. For a large class of work the process of striking circles from the given centre, marking these circles with a centre-punch and keeping the drill within the circle by "drawing" it with a small round chisel, may be employed; this method, however, is not sufficiently accurate for exact work, as it is extremely difficult to get a drill started exactly right within a scribed circle, even if the circle itself is true, which is unlikely when marked out with dividers.

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* Institute of Civil Engineers, Foreign Abstracts.

The method indicated at the commencement of this article will give very good results; but when possible a brushing should be provided for the boring-bar to work through.

When it is necessary to set out the work and mark the centres of the holes with the punch, the holes can be made true with the centre marks by means of the following device:—A piece of steel is provided into which two bushings are driven, having holes of any convenient size. These bushings are lapped out and ground true before being driven into the plate, and twist drills are ground to fit them as closely as practicable. Two plugs are ground to fit the bushes closely, having at the same time small conical points ground on them so as to be quite true. Then, supposing the holes to have been set out correctly, one of the plugs having been pushed through the bushing so that it projects a little below the plate, the point is put into the centre mark; then, holding it in position, the plate is pushed down on to the face of the work and clamped; next the plug is withdrawn, leaving the bushing exactly centred over the mark. Now the drill may be put in and the hole started, after which the plate should be removed to prevent wear of the bushing, and the drilling finished.

MODERN MACHINE TOOLS.—II.

The interesting character of Mr. Dixon's inaugural address, delivered before the Manchester Association of Engineers, warrants us in giving a more extended notice of it than we were able to do last week.

During the past twenty years great strides had been made in the improved construction of machine tools, and for the purpose of considering some of the features of modern machines, he asked his hearers to accompany him mentally around, in the first instance, a well equipped establishment adapted for general engineering work, and to commence in much the same manner as the work. Although it was his intention to consider more fully the machines adapted for the cutting of metals, it would be advisable to take first a view of the foundry. Here there was nothing in the actual process of moulding that was very new, except it was the capacity for making immense castings. In connection with moulding he might mention a curious practice he had met with in a Belgian workshop, which was, he believed, the only place in the world where moulds were made from drawings only, or perhaps he should more correctly say without patterns, and these not simple, but in many cases extremely difficult ones. The castings he examined seemed perfect in every respect, and although he could not speak as to its economy, yet he was assured by one Corliss engine builder, who had all his castings made by this process, that there was distinct economy in it; he simply sent his drawings to the foundry, and had made no patterns whatever since this method had been adopted. In considering next the production of forgings, although the skill of the smith must, in this branch, ever remain a prominent element, especially among small work, yet the modern methods introduced materially tended to reduce the personal element; and at the same time produce work infinitely superior, both in size and quality, to that produced by the last generation. Passing on next to what was usually the first step in finishing, that of planing, they had a machine which was entirely the development of the present century, and about the origin of which an exceedingly hot controversy had raged. From the table driven by a chain, and running on numerous friction rollers, it was by Whitworth much improved, as he recognised the vast importance of accurate slides. The forms of these slides were originally vees, or one vee and one flat, and these vees, after gradually increasing in the angle, had steadily approached, and had now in the most improved machines become flat slides. These, with vertical guides to prevent the lateral motion of the table, were capable of taking heavier cuts with the same strap power, the vertical guides preventing the possibility of the table yielding when taking heavy side cuts. Why the vee forms were ever adopted he could never make out, for the lubrication was quite as easy in the flat slides as in the vees. For most ordinary dimensions of objects—say, up to 30ft. by 10ft.—it was still the practice to reciprocate the work upon a table rather than traverse the tool, but this raised an important feature in machine tool construction, to determine the limit at which it was more profitable to move the cutter to the work rather than the work to the cutter. Considering the question of space alone, the former required for an object 30ft. long a shop length of at least 60ft., whereas by the latter it would be accomplished within a length of about 36ft.—an important consideration. Considering the question of the weight of the object, it would certainly seem more natural to manipulate the tool rather than the work. This had been to some extent adopted, particularly in those immense side planing machines where objects of any size may rest upon a foundation plate, and have the sides planed 10ft. or 12ft. high, by a tool traversing either longitudinally or vertically. In the most modern planing, the various motions of the tool were so arranged as to plane every side except one (that upon which it rested on the table) of a complete cube, and these perfectly true with each other, and also at one setting. One might indicate some of the lines upon which it was probable the future planing machine would be developed, but as its very existence was menaced by the advancing milling machine, he did not think it profitable to pursue the question further. The next group of machines they came to were the boring machines. The process of boring, as they were all well aware, was one of great antiquity, but for anything approaching really accurate boring, they must not go any further back than Watt's time. The methods of procedure for such objects as cylinders seemed to differ somewhat, but the most modern practice was to take a heavy roughing cut through the hole, and then finish by a light cut having a traverse of some ⅜in. to ½in. per revolution, thus avoiding the wear of the tool, which, of course, tended to make the hole conical. The boring of large objects was one giving rise to many special forms of machines adapted for particular purposes, but the general tendency of all modern work among large objects was to machine as many parts as possible at a single setting, thereby ensuring greater accuracy, and the saving of the time required to transport the object and re-set upon another machine. The slotting machine invented by Roberts, about the year 1820, remained much the same in general form to day as when it left his hands, except that it had now grown to enormous proportions. This machine, together with its sister the shaping machine, invented by Nasmyth, had, however, been greatly improved in details tending to eliminate the points of weakness, and to give them greater solidity and capacity for heavy cutting without vibration. From the time when Watt, he believed, first constructed the power drilling machines, there had been one steady advance in the improvements of this tool, all tending towards increased solidity and accuracy, as well as facility in the setting of the work. These had been rendered necessary by the introduction of twist drills, which enabled much heavier cuts to be taken. The next group they came in contact with was that of the lathes, the origin of which remained in the greatest obscurity, being probably a continuous development of the potter's wheel. Before the introduction of steam driving power, the lathe remained an extremely simple machine; but by the practical introduction of the slide rest by Maudslay it had been transformed and developed to an enormous degree. The modern capacity of steel works for producing heavy forgings had required the construction of enormously powerful lathes, but with constructions steadily increasing in size. The consideration of how to turn the heavier pieces had in many works led to the great neglect of the cost of producing the small pieces, such as studs, pins, screws, etc. A comparatively recent development of the lathe had been for the purpose of making articles in duplicate; and this was well illustrated by the latest forms of lathes for brass finishers.

LUBRICATING HIGH-SPEED JOURNALS.*

The writer, in No. VI. of a series of papers on "Suggestions in Machine Designs," describes a method of lubricating, with which he has attained excellent results, and which he believes to be new, applicable more especially to loose-running wheels or pulleys. The pin on which the pulley runs is bored up the centre, and one or more small holes are drilled through the shaft to meet the centre hole; in the cross-holes loose pins are placed. The pins rest against the bore of the wheel, and are kept in vibration by the motion, and so keep up a flow of lubricant, after the manner of the stylographic pen or the needle lubricator. The oil is supplied through the centre hole.

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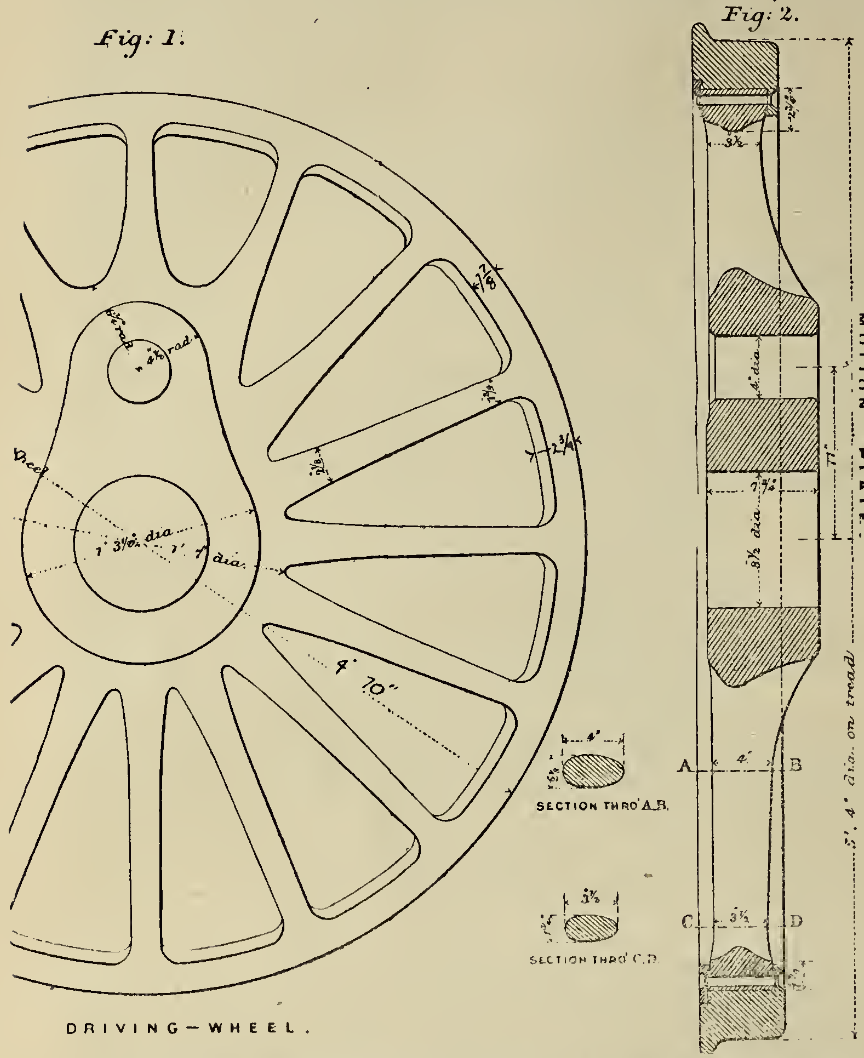
* Institute of Civil Engineers, Foreign Abstract.

THE USE OF CAST STEEL IN LOCOMOTIVES.—II.*

Continued from page 32.

Fig: 1. Fig: 2.



DRIVING—WHEEL.

Fig: 4.

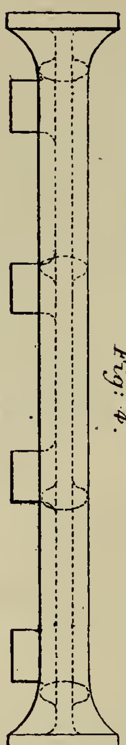
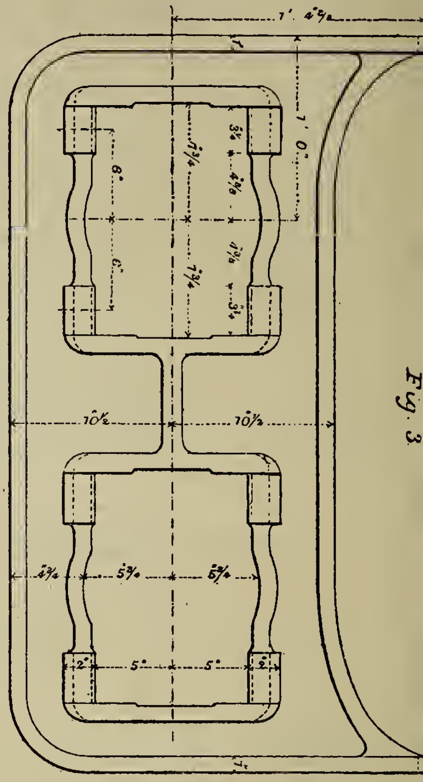
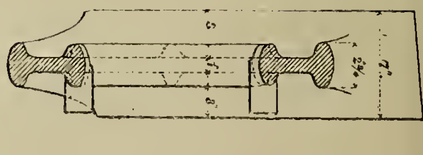


Fig. 3





The majority of locomotives in this country have been built with wrought iron wheels; but the Great Eastern Railway Company has, during the last three or four years, been using a considerable quantity of both cast iron and cast steel wheels, the cast iron being used only for goods engines and shunting tank engines, whereas wheels made of cast steel have been used for the bogie wheels of express engines, and for all the wheels of passenger tank engines, besides a great many for tenders.

In figs. 1 and 2 are shown a driving wheel as used for a passenger tank engine; the diameter of the wheel on the tread is 5ft. 4in., while that of the casting is 4ft. 10in., a rolled steel tire 3in. thick being fastened to the casting by means of sixteen ¾in. rivets passing through the lip of the tire on one side and a Mansell ring on the other; there are sixteen egg-shaped spokes, tapering from 4in. by 2½in. to 3½in. by 1⅝in. The price of a cast steel wheel of this sort, as turned out of the foundry, compared with that of a wrought iron wheel as turned out of the smithy, shows a saving of about 12 per cent. in favour of the steel, and the casting does not require so much machining as the forging; but this is perhaps balanced by the fact that the steel being harder than the iron, it is necessary to run the machines for turning, boring, etc., at a somewhat lower speed. Wheels which have no crank boss can be forged at about the same cost per cwt. as steel castings, or perhaps a trifle cheaper; but, even in this case, the difference in weight is sufficient to give the steel wheel a slight advantage. Bogie wheels with flanges cast on them, to avoid the necessity of adding tires, have been tried. Hitherto, as far as the wear is concerned, they have given very good results; but the disadvantages attending their use for locomotives are greater than the advantages; the author, however, believes this class of wheel to be very suitable for trollies, trams, etc. The author is informed that the London and North Western Railway Company has in use a great many cast steel wheels, which have been made at the Company's works, at Crewe, by the following method. The pattern, an iron one, is rammed up in a circular box, which is afterwards placed on a table about 7ft. in diameter; this table, which is driven by a Brotherhood three-cylinder engine, is a capstan with the head taken off, and the table put on in its place. During casting, the table revolves with a speed of from fifty to sixty revolutions per minute. The object of thus revolving the mould while the metal is being poured is to diminish the liability of having blow-holes in the rim, the centrifugal force causing the metal to flow freely outwards; it is, however, found necessary in large wheels to cast a web about 1in. thick between the spokes at the rim and boss to still further failitate the flow of metal; the webs are afterwards slotted out.

Figs. 3, 4, and 5 show a cast steel motion plate suitable for passenger tank engines. These engines are fitted with four slide bars. Previously to the introduction of cast-steel, the motion plates for similar engines had been built up of plate and angle iron, and the brackets for carrying the slide bars were bolted on, and consequently were subject to the rivets and bolts working loose; it was also necessary that great care should be exercised, so that in fitting up the brackets they might be perfectly square, to lessen the friction of the slide block. Cast iron plates were afterwards tried, but did not prove satisfactory, owing to the low tensile strength of the material, and its liability to fracture under any sudden jar. The steel casting, as shown, was then adopted. The flat portions of the plate and the side flanges are 1in. thick, the latter being 7in. wide; all the edges of the spectacle holes, and the top and bottom are strongly ribbed; eight lugs are cast

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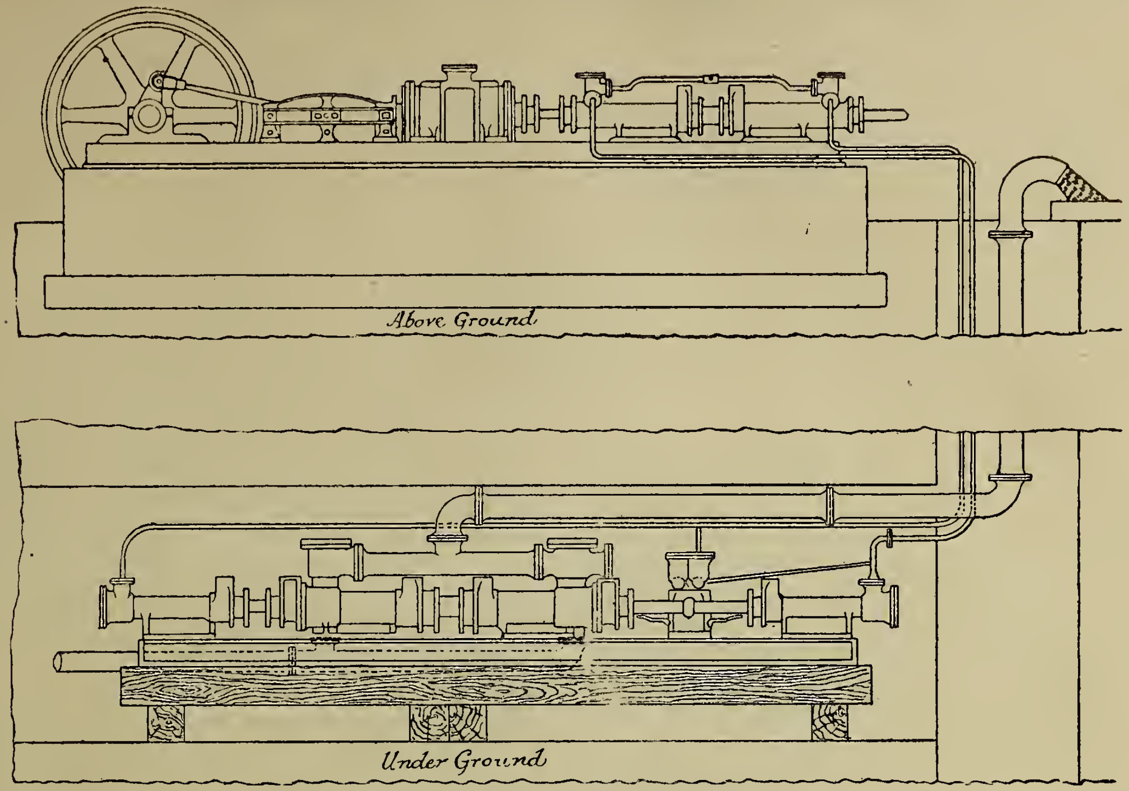
* Paper by A. J. Hill, Wh. Sc., read at a meeting of the Students (Inst. of Civil Engineers), and awarded a Miller Prize in the Session 1886-87.

MOORE'S HYDRAULIC MINE PUMP.



at the back of the plate to which the slide bars are bolted; the faces are of course machined, and also the side flanges; the plate is riveted to the frames by twelve $\frac{7}{8}$in. rivets in each side; these rivets are turned and riveted up cold. Motion plates in cast steel for goods engines fitted with a single slide bar are also used; these are similar to those which have been already described, with the exception of the lugs for carrying the bars.

MINE DRAINAGE.

A very ingenious method of raising water from mines is by means of Moore's hydraulic mine pump. An ordinary horizontal steam engine placed on the surface works, a double acting water-ram also on the surface. A strong wrought iron tube connects the two ends of the water ram case, and also from either end of this case a power pipe is carried down the shaft to the bottom, or to any point in the workings where it is convenient to fix the hydraulic pump.

The hydraulic pump consists of a double plunger pump, having connecting rods projecting through glands at each end, and these are made a suitable length to form the plungers of two hydraulic rams, placed at either end of the main pump as shewn on the sketch. The two power pipes after being carried down the shaft are connected to the outer end of each hydraulic ram. The main pump is double acting, and has two suction valves and connections to a single pipe from the sump or cistern, and also two outlet valves and connections to the rising main. Protection against shocks caused by the stoppage of the moving power column, or by irregularities between the motion of the engine rams, and the underground hydraulic rams is obtained by a connection between the two power pipes, and by providing a relief valve, which, when opened, allows the water to pass from one column to the other. The hydraulic ram gives motion to a small bell crank at the end of each stroke, which works the relief-valve. The reciprocating action of the engine rams on the surface is transmitted direct to the under-ground hydraulic rams, the water forming a rod which receives motion from the engine rams at one end, and transmits it to the hydraulic rams at the other, there being no valves whatever between. The water in the power pipes should be quite clean when first placed there, and is not afterwards changed. Care must be taken, however, to maintain the column of water solid, so as to completely fill the ram cases and the power pipes; and to provide against leakages, small inlet valves and pipes, connected to a cistern, are placed at a higher level. If the pump is a small one, the steam engine on the surface may be direct-acting; the piston rod passing out through the back cylinder cover, and there connected to the water ram. With large pumps, a small engine running at a high speed may be geared to the pump, as the water in the power pipes must not have a high velocity. The engine should have a heavy fly-wheel on the crank shaft. The power columns are worked at a high pressure—about 1000lb. to the square inch. The area of the rams and power pipes should be so proportioned that the rams travel at a speed of about 80ft. per minute, and the speed of the water in the power pipes may be about 300ft. per minute. The relative sizes of the plunger pump and the hydraulic rams must necessarily vary with the quantity of water and height to which it is to be raised, and also with the pressure at which it may be decided to work the hydraulic rams.

A great advantage from this system of pumping water out of mines, consists in having no moving rods in—or beam over-hanging—the pit, no leaky steam pipes in the shaft; the only moving parts being at the engine on the surface, and at the hydraulic pump underground, and further, the power pipes take up less room in the shaft than pump rods. It is applicable to pump water in a shaft from any depth, or from dip workings which may be at a considerable distance from the shaft, or it may be used in a sinking pit. Where used to drain a sinking shaft the pump and pipes work in guides, and are suspended by two chains of rods from an hydraulic ram fixed on the surface, and lowered as the sinking proceeds.

When a shot has to be fired in the bottom the whole arrangement is raised a few feet out of the pit bottom by the hydraulic ram. The shot having been fired without injury to the pump, the latter is again lowered into its place in the sump.

Proposed Shipping Bounties.—The Convention of the American Shipping League has adopted a "platform," asking Congress to pass a bill giving American vessels engaged in foreign trade a bounty of 30 cents per ton for every 1,000 miles sailed, this allowance to continue for 10 years, and for nine years more with an annual reduction of 3c. per ton, and also recommending the construction of a strong navy, the improvement of river harbours, and the provision of means for carrying foreign mails in American vessels.

THE DUDLEY BOILER EXPLOSION—I.

FORMAL INQUIRY.

The formal inquiry by the Board of Trade regarding the above explosion, to which reference was made in our issue of the 13th instant, was held at the Town Hall, Brierley Hill, on the 11th, 12th, and 13th instant, before the commissioners, Mr. Mansel Jones and Mr. Druitt Halpin, the inquiry being conducted by Mr. Howard Smith, instructed by Mr. Gough, of the Solicitors' Department of the Board of Trade. As we have already stated, the inquiry is of particular interest to steam users and boiler insurance companies, in consequence of its being the first of the kind that has been held under the Boiler Explosions Act. The investigation was of a very exhaustive character, but want of space forbids our giving more than an abstract of the leading portions of the evidence, though we have pleasure in accompanying the same with several illustrations in order to render it more intelligible to our readers.

Mr. Howard Smith, in opening the inquiry, gave a brief history of the boiler, pointing out that it was made about thirty years ago, and from the year 1863 down to the date of the explosion had been under the inspection of the Midland Boiler Assurance Company, with whom it was also insured in 1882 for the sum of £500. After tracing out the main incidents in connection with the explosion, and stating that there was a concurrence of testimony amongst the scientific witnesses that the explosion was primarily due to the rupture of the boiler at one of the vertical seams in the cylindrical part of the outer shell, in consequence of the existence of an old flaw, Mr. Smith said one of the most important points for the Court to consider would be whether the inspection of the boiler had been adequate, and whether, looking at the age and the existence of defects that could have been seen on examination, the inspector should not have had his suspicions aroused, and, either by more careful inspection or the application of the hydraulic test, have discovered the hidden flaw of the vertical seam from which the explosion sprang.

The first witness called was Mr. Leacroft Freer, the senior partner of the firm owning the works in which the explosion occurred. He said there were twenty-two boilers altogether at the works, nineteen of which were of the Rastrick type, all fired in the same way. From an examination of their books it appeared that the one which burst was supplied somewhere about 1853 or 1854. The iron of which the boiler was made was, he believed, originally made at the works, this being their usual practice. For making boiler plates they always used "Best South Staffordshire" iron, and he was of opinion that the plates which had failed were part of the original structure.

William Icke, engineman on duty at time of explosion, said he had had charge of the boilers for eight years. On the evening of the explosion he found everything in connection with the boiler in usual working order. He went round and examined all the boilers about once every quarter of an hour, and tested the floats and safety valves of the one in question about ten minutes before the explosion. The safety valve was then blowing off. He had no reason to believe the valve had got stuck fast, and had never known a valve to stick.

Questioned by the Court, witness said the engines were lubricated with cylinder oil, the supply being regulated with a sight-feed lubricator. The water for the boilers was obtained from the hot well of the engine. It was rather hard and limy, and some times not very clean. They did not use any boiler composition.

William Clissold, mechanic, said he had charge of all the engines and boilers in the works, and was responsible for everything being kept in order. There was no separate pressure gauge on each boiler, but there was one in each engine-house, making four altogether for the twenty-two boilers, and this he considered satisfactory so long as the stop valves on the boiler were open. If they were shut, then, of course, there would be nothing to indicate the pressure. The safety valves on all the boilers were loaded to 30lb., the pressure being regulated by the gauge. There were rods hanging from the weighted end of the lever as well as from the end of the counterbalance. One was for hanging weights on in order to make the valve blow off sooner; the other was for shutting the valve if it happened to be slow in closing. Since the explosion the rods hanging from the weighted end of the levers had been all removed, and he now thought they were undesirable. He could not remember that the Insurance Company had ever complained about these rods. He personally inspected the boilers each time they were laid off, which would be about once every four weeks, and had had repairs done to the boiler on several occasions. It had been necessary to remove brickwork sometimes in order that the repairs might be effected. When he last examined the boiler he did not notice the wasting of the plates and rivet heads at the part which had failed, though he could see it now; nor had he noticed the existence of old fractures. He had never applied the hydraulic test to this boiler, although he had tested two of the others in that manner. He did not receive any special instruction from the Insurance Company with regard to the preparation for inspection. The inspector, however, generally came on a Monday, because the boilers were almost invariably laid off on that day. He thought none of the fractures which had existed could have been discovered by inspection. If he had known of their existence he would at once have stopped the boiler. He had met with seam-rips in the sweep plates of this boiler, and they were repaired; he had also found seam-rips in the cylindrical portions of two other boilers at the works. He found the sweep-plates opposite the necks of the furnaces were very liable to suffer from edge-cracks or lap-fractures, in consequence of the heat being most intense in that part. Since the explosion, all the boilers in the works had been tested with hydraulic pressure to 45lb., but they had not found any fractures in any of them. The boilers were examined internally and in the flues once every year by the Insurance Company's inspector, who, in addition, also examined them three or four times a year under steam.

Mr. Freer, recalled, said the boilers were placed under the inspection of the Midland Assurance Co. in 1863, and from that time to 1882 they paid for inspection the sum of £13. 13s. per annum for twenty-one boilers, being at the rate of 13s. per boiler per annum. In 1882 the boilers were also insured on the group system for £500, the annual premium being £36. 15s. The policy of insurance, along with the reports received from the Midland Company, were here handed to the Court. Referring to the exploded boiler, witness was not aware that the Company had ever recommended the brickwork to be taken down, or that they had ever called attention to the existence of the cracks or wasting of the rivet heads. The day after the explosion the firm received a report from the Company, the substance of which was that the boiler in question was in safe working order. The report called attention to several slight defects, but there was nothing to lead them to think repairs were necessary or called for.

[The conclusion of our report of the procedings, and the illustrations, we are obliged for want of space to leave over till next week.]

CONTINUOUS AIR BRAKES.

At a meeting of the King's College Engineering Society, London, on Tuesday, January 24th, the President in the chair, Mr. Barratt read a paper on "Continuous Air Brakes." The author commenced by giving the necessary requirements for railway brakes, as issued by the Board of Trade; he then divided the brakes as used in Great Britain into two classes, namely, vacuum and compressed air. In Smith's system, the brakes are applied by creating a vacuum in the train pipe and sacks by an ejector on the engine. In Hardy's automatic vacuum, a vacuum is maintained in the reservoirs and train pipe; on destroying the vacuum in the train pipe communication is set up between the reservoirs and sacks, the vacuum in the former causing the latter to collapse, and so applying the brakes. He then described Saunder's brake and the successive improvements that it has undergone. Among compressed air brakes, Steel and McInne's automatic brake was described. In this brake the cylinder and reservoir are combined in one, the piston working vertically in the upper part, and the lower part being enlarged to form a reservoir for compressed air; when the brakes are off the piston is at the bottom with compressed air above and below; to apply the brakes, the pressure is reduced above the piston, and the compressed air in the reservoir below forces it up and so applies the brake. The Westinghouse brake was then gone into very fully. In this brake there is a small reservoir on each carriage, and a large one on the engine; pressure is kept up in the train pipe to keep the brakes off, and on reducing this pressure, by the action of a triple valve, the compressed air in the reservoirs is admitted in to the cylinders. In the discussion which followed, Mr. Brydges, Mr. Gask, and Mr. Sparks took part. Mr. Brydges gave a description of the

Sloan and Hawkes brake, the chief feature of which is that an increased load on a carriage causes the brakes on that carriage to increase their pressure, and so overcomes the difficulty of the wheels of lighter carriages skidding from applying the brake too hard. Mr. Sparks described the interchangeable automatic compressed air brake. After a vote of thanks to Mr. Barratt, the meeting adjourned.

ENGINEERING TRADE IN 1887.

Messrs. Matheson and Grant report as follows respecting the engineering trade of 1887 :—Trade has continued to improve during the last three months ; there has been a marked increase in the value of exports, and in most branches of engineering the prospects for the opening year are favourable. The introduction of late years of automatic and labour-saving machinery has much to do with the low prices that prevail, for while the volume of trade has increased, the producing power of the country has grown still more rapidly. The revival must to some extent be associated with that in the United States which preceded it, and this great activity in America, where during the past year more than 10,000 miles of new railway have been constructed, seems likely to continue. There is no immediate prospect of any reduction in the tariff, as seemed foreshadowed by the President's Message to Congress, and this postpones a serious and possibly overpowering competition with Great Britain, which will arise directly the removal of protective duties in the United States brings the cost of living, and therefore that of production, to a normal level, and allows full development of the enormous natural resources of the country. Iron and Steel Shipbuilding.—A marked recovery has taken place during the last few months from the depression of the preceding three years, and this improvement is the most significant sign that a general revival has at last commenced in the engineering trades. In Scotland shipbuilding reached its maximum in 1884, when nearly half a million tons were launched ; freight rates rapidly fell under the increased competition of shipowners, and in 1886 less than 200,000 tons were built. Although the recovery has come too recently to influence much the statistics of the year just closed, the contracts entered into since September aggregate a greater tonnage than has ever been given out in a similar period. Steel has at last entirely superseded iron as a material of construction for steamers, for while in 1879 only 10 per cent. of the total vessels built were of steel, in 1887 the proportion was 80 per cent., and the remainder were almost entirely sailing vessels. In boilers the same revolution has taken place ; steel allows the higher pressure of steam which is essential to economy of fuel, and further progress in this direction is going on. Triple expansion has been successful with steam at 150lb. pressure, but the same principle carried out by quadruple expansion will be still more advantageous if an initial pressure of 200lb. be given in the first of the four cylinders. This is likely to be the maximum till invention takes a new departure. Steel and Iron Bridges.—All the principal factories have been fairly well employed during the past year, but prices have been and still remain at a level leaving only the barest profit. Mild steel with a tenacity ranging from 27 to 32 tons per inch is now accepted as the best material for bridges, and although not yet used much for spans under 100ft., and hardly at all for roofs, its universal adoption cannot much longer be delayed. At home the Forth Bridge is making rapid progress and, as far exceeding in magnitude all other structures in the world, is receiving the attention of engineers everywhere. The superstructure of the Tower Bridge will be commenced this year, and smaller bridges over the Thames, the Dee, and other rivers are in progress. There is, however, little new work of this kind, and it is in bridge widening, station extensions, and additions to old structures that most of the home expenditure is applied. This branch of trade depends mainly on export, India, South America, Japan, and more recently China being the countries which have given employment during the past year. English engineers still prefer riveted bridges ; American designers are approaching nearer than formerly to English solidity and methods, and in weighing the respective merits of pin connexions and rivets it must be taken into account that the improved workmanship in this country, the planed abutting edges, drilled rivet holes, and hydraulic riveting enhance considerably the advantage of the English system, and render it more than ever preferable against the severe stresses of modern railway traffic. Locomotives and Rolling Stock.—During the past year there has not been the extreme depression which in 1886 brought many firms to the verge of collapse, but with few exceptions manufacturers have had during 1887 to work for very little profit. The large factories of the railway companies are still the great hindrance to improvement at home, but the prospects for foreign orders are better than they have been for the last few years. India, Burmah, the Colonies, South America, and Japan have been the chief sources of employment, and the inquiries now coming forward justify expectations for the immediate future, although it will be some time before prices improve beyond what may be due to the higher cost of material. There is great activity in the United States ; car builders are particularly busy there, and this reduces the competition of American makers in neutral markets. Compound engines, with various adaptations of the three-cylinder principle, are slowly growing in favour, while in carriages the use of steel in the under frames is being more widely applied. The manufacture of tram cars and tram engines now forms an important adjunct to this branch of the engineering trade.

A NEW DEPARTURE IN BRAZING AND WELDING.

Mr. Thos. Fletcher, the well known gas engineer of Warrington, writes to say: The cheapening of oxygen by Brin's process of manufacture has put into the hands of metal workers a new power. I have recently made a few experiments with the compressed oxygen and coal gas, and found that with a half-inch gas supply a joint could be brazed in a two-inch wrought iron pipe in about one minute, the heat being very short, the redness not extending over one inch on each side of the joint.

The appearance of the surface after brazing led me to experiment further with welding, a process which is not possible with ordinary coal gas and air owing to the formation of magnetic oxide on the surfaces. Contrary to my expectation, a good weld was obtained on an iron wire $\frac{1}{8}$in. diameter, with a very small blowpipe having an air jet about $\frac{1}{32}$in. diameter. This matter requires to be taken up and tried on a large scale for such work as welding boiler plates, which, it appears to me, can be done perfectly with far less trouble than would be required to braze an ordinary joint. The great advantage of this would be that the boilers would require no handling, but could be welded with an ordinary large blowpipe in position, and with about one-tenth the labour at present necessary.

The cost of the oxygen is trifling, and it is evident from the results obtained in brazing that the consumption of gas would be considerably less than one-fourth that necessary with an air blast, irrespective of the fact that welding is possible with an oxygen blast, whereas it is not possible if air is used.

The surface of iron heated to welding heat by this means comes out singularly clean and free from scale, and a small bottle of compressed oxygen, with a blowpipe and a moderate gas supply, would make the repairs of machinery, boilers, brewing coppers, and other unwieldy apparatus a very simple matter. The trouble and difficulty of making good boiler crowns, which so frequently "come down," would be very small indeed when the workman has an unlimited source of heat at command, under perfect and instant control.

SOFT LOCOMOTIVE EXHAUSTING.

Mr. Angus Sinclair, in his usual style, makes the following remarks in the *National Car and Locomotive Builder* :—" I arrived at Knoxville at night, and went to a hotel beside the depot. In the morning I stood in my room for some time watching the movement of trains, and I was struck with the soft sound of exhaust made by the locomotive, a thing that appeals readily to the ear of a locomotive engineer. On meeting Mr. Thomas, this naturally became the first matter that was inquired into, and I found that he had devoted a great deal of attention to the subject of draft appliances, and was successfully running 17 × 24in. engines with single nozzles from $4\frac{1}{2}$ to 5in. diameter. For the larger size of engines he has the nozzle $5\frac{1}{2}$in. diameter. The advantages of this thing of opening up the of coal by the exhaust having a mild action on the fire; and secondly, the engines work much more freely, owing to the absence of back pressure in the cylinders. These advantages are beyond question, and they materially reduce the operating expenses of a road ; yet it takes no end of preaching to make some master mechanics believe that the engine which does not exhaust the steam with a ringing loud sound is capable of doing any work."

CORRESPONDENCE.

We do not hold ourselves responsible for the opinions of our Correspondents.

AN ENGINEER'S LIFE AT SEA.

To the Editor of "The Practical Engineer."

Sir,—Your correspondent says many omissions will be accounted for by the fact that it is only one individual's experience, therefore he will excuse me writing. Of course many engineers have entirely different styles of working, and it will, no doubt, be of interest to know more than one. Thus, while I was third and fourth of a mail steamer, the chief engineer always had the fires lighted twelve hours—not four hours —before sailing time, and I have always been accustomed to see the water in the boilers two or three days before starting, in order to see if everything were tight, as usually odd jobs had been done to the boilers in harbour. Again, the syphons were made and the boxes filled with oil the day before sailing, not left till an hour before, when there is quite enough to do warming through. It must also be a queer engine that requires the turning gear. to be left in till close on sailing time, she could not be very well balanced.—I beg to remain, etc., B. W. G.

ECONOMISER EXPLOSIONS AND THE BOARD OF TRADE.

To the Editor of "The Practical Engineer."

Sir,—I read with great interest the report of the Board of Trade on the late economiser explosion at Middleton Junction, which caused such a deal of discussion last year in your valuable paper. I am quite sure that the verdict, which sounds thoroughly absurd, will not satisfy the majority of engineers. I have known economiser pipes to have wasted away to the thinness of a sixpenny piece, and then only in machines having done between fifteen and twenty years' service. Now if the Middleton Junction economiser pipes had wasted away to the above thinness they would have exploded singly. There can be no doubt the safety valve was stuck fast, or that the bottom boxes were choked up with mud deposit. It is quite true, what you point out, that many people are under the impression that an economiser is an auxiliary boiler, which is quite wrong. I have known engineers who have said, "Never mind an extra boiler, put an economiser in;" and, "put two boilers in, and do away with the economiser." The verdict plainly shows that the Board of Trade inspectors are not competent to investigate such explosions, and should be left to better men—men who understand the machine.—I remain, yours truly, Economy.

PLATE FLANGEING.

To the Editor of "The Practical Engineer."

Sir,—Your correspondent "A. S." in discussing the construction of the dished ends of the kier made by Joseph Adamson and Co., and described in your paper some little time ago, appears, like several other of your correspondents who have written on the subject, to overlook the fact that there is all the difference in the world between forming a shallow flange round the circumference of a plate, such as is shown in the sketch accompanying his letter, and moulding a flat plate into a hemispherical shape. The plate shown in his sketch has a diameter of 3ft. 6in., and has an outer and an inner flange formed on it, each less than four inches deep. The ends of the kiers in question had a diameter of nearly 7ft., and were compressed almost into a hemispherical shape, being at the same time—and therein, sir, lies the feat—entirely free from wrinkles. That your correspondent should consider the flangeing of the plate shown in his letter, and the formation of a smooth hemisphere, as comparable pieces of workmanship, simply shows that he is unacquainted with the difficulties involved in the production of the latter, and, if he will just try and make a hemisphere out of a flat plate, I think his respect for the kier ends referred to will be very much increased. I speak, sir, with full knowledge of the case, and of the difficulties involved, and think that the fact that no other firm in Lancashire besides Messrs. Joseph Adamson could at the present moment turn out such a piece of work as that described in your notice, fully entitles it to be regarded as "a feat in boiler construction," and, like many others of your readers whom I know, I shall continue to consider it as such until somebody else makes a similar article.—I am, sir, yours truly, Hemisphere.

January 23rd, 1888.

QUERIES AND REPLIES.

Signalling.—Will any reader give me the most approved method of signalling in long and steep inclines, and the advantages over the old wire and hammer system.—W.A.

Answer.—In answer to "W.A," the most approved method of signalling in long and steep inclines is that known as the electric method. It is best to have two wires the whole length of the road, running about six inches apart, parrallel to each other, attached to supports about every 20 yards or so, according to circumstances. At the point to which it is required to give the signal must be fixed an electric bell, and likewise a battery, with sufficient jars to keep the apparatus supplied with electricity. If there is a return wire, signals may be given in any direction. If the road is wet in places, insulated wire should be used at these points, but as "W.A." does not give any details as to the road, I cannot very well answer fully, but if he thinks it worth while, and will write again, giving full particulars, I shall be glad to give a full description and also an estimate of the probable cost. The advantages over the old bell and hammer system are obvious. All that is necessary in the electric system is to bring the two wires together, and contact is at once formed, and the bell immediately rings. This can be done in any part of the incline It is as easy to ring 1000 yards away from the engine as 100 yards ; less effort is required to ring the bell, whilst in the old wire and hammer system, signals can only be given in most cases from the terminus, where the handle is fixed up. In the electric system the wire is not weighted, consequently a less expensive wire will do, whilst in other respects its first cost and maintènance will favourably compare with the old bell and hammer system, whilst for every day use and quick signalling, the old bell and hammer system is nowhere.—Mining Engineer.

Marine Problems.—(1) Suppose a marine engine to be developing the full horse power, will it, when the steamer is making its way up a river, give the same number of revolutions as when the steamer is going down the river, neglecting the friction of the air due to the varying speeds of the vessel in the two cases? (2) A steam ferry boat requires to cross a river in a straight line, but owing to the current the steamer has to be headed partly up stream all the way across, and thus it crosses in a straight line, but in a sideway position. Will the pressure of the current on the vessel be greater or less on the upside than on the down side?—R.J.G.

Answer.—(1) In answer to "R.J.G.'s" query, I beg to say that the effect of the river current when the boat is free to move in and with the current, makes no difference in the power developed by, or the number of revolutions of, the engines in a given time (say an hour), during which time we are assuming that they are developing their utmost effect; whether the boat move up-stream, down-stream, or at any angle with the direction of the stream, no difference is made in the power developed by the engines, or in the number of revolutions performed by them; but a very considerable difference may be made in the distance passed over by the boat during that time, the amount of that difference being dependent on the respective velocities of the boat and current, combined with the respective directions of the motions of each. Let the velocity of the boat per hour, through still water when the engines are developing their utmost power be V miles, and the velocity of the current during the same time be v miles. Then when the boat is propelled by the engines along with the current, its velocity on the space passed over by it per hour will be $(V + v)$ miles; and if propelled against the current, the space passed over will be $(V - v)$ miles per hour. And generally, if the boat go in any direction, and the angle between the line of keel of the boat, and the axis of the stream be represented by A, then the velocity or space passed over by the boat per hour $= \sqrt{V^2 + v^2 - 2Vv \cos. A}$ (the cos A being positive, when heading up stream, and negative when heading down); while the power developed, and the number of revolutions made by the engines are in each of these instancss the same.—W.A.

(2) The revolutions will be the same in both cases, the only difference being the speed of the vessel; for instance, assume velocity of stream to be four knots per hour, and speed of vessel in still water eight knots, then the vessel will make four knots against the stream. Now turn the vessel's head round with the stream, the velocity of the stream alone will carry the vessel along at the rate of four knots: now the vessel is in the condition of being in still water, and on the full power being again developed, the vessel will make, with the same number of revolutions as before, eight knots independently of the velocity of the stream, therefore the only difference being 8 + 4 = 12 knots instead of four as before against the stream, the revolutions remaining the same. The pressure against the side opposed to the direction of the stream will be greater than on the opposite side, the amount being determined by the velocity of the stream.—J. R.

Engines of the Etruria.—Could any reader supply me with the leading dimensions of the engines of the *Etruria*, or *Ormuz*

Answers.—(1) The engines in the steam ship *Etruria* are of the ordinary compound type, having high pressure cylinder of 71in, diameter. working at an initial pressure of 110lb., and exhausting into two low pressure cylinders, of 105in. diameter, not directly, but through a receiver. The stroke is 6ft. and the engine makes generally from 62 to 65 revolutions per minute. but the maximum is 69. The propeller is 246in. diameter, and has a pitch of about 33ft. The condensing surface covers an area of 36,000ft, upon 9000 tubes. The condensers discharge about 360 tons per hour. These engines indicate 15,000 horse power. Steam is supplied by nine boilers, 17ft. long and 16½ft. diameter, constructed of steel, and fitted with 27 safety valves, the area of which amounts to 763 square inches. Two low water gauges and two fusible plugs are fitted to each boiler. These were built by Elder and Co., Glasgow, and I may add that they have proved very successful in their working during the last three years.—F. Grover.

(2) High pressure cylinder in the centre, two low pressure cylinders, one on each side. High pressure 71in., low pressure 105in. each in diameter; stroke 72in. Steam pressure, 110lbs , nine boilers. Heating surface 38,817 square feet, bar surface 1606 square feet. Consumption of coal 315 tons per day. These refer to the *Etruria.*—J.H.

(3) Engines of the *Ormuz*. Triple expansion, cylinders 46in., 73in,, 112in. diameter respectively, stroke 6ft. Six double ended boilers, each 15ft. diameter, pressure 150lb. Indicated horse power, 9,000 on trial trip.—J.H.

Guide to the Indicator.—What is the price, and who are the publishers of "Wood's Comprehensive Guide to the Steam Engine Indicator?"—R.W.

Answers.—(1) You can get Wood's book from Thomas Reed, 184, High-st.. West, Sunderland. The price is 12/6.—J.H.

(2) Mr. Wood's address is—Mr Benjamin Wood, 44, Woodsley Road, Leeds, and the price of his book is 12/6. I think it ought to be in the hands of every engineer.—J. Barraclough.

Copper Balls.—Could any reader oblige with information as to how the halves of copper balls (similar to those used for water ball-valves) are made. Is the copper pressed to shape between top and bottom dies, or is it spun or gradually worked into a corresponding half-mould, in a lathe or similar machine? I want to make some about 3in. diameter.—Sphere.

Answer.—I do not think these are ever stamped in dies, but spun, when small, in a spinning lathe, the disc of copper being pressed against a convex mould "form," or of pine wood, attached to the face plate, the metal being gradually folded over, by means of a hard steel burnishing tool. The edges of the two halves, when spun, fit one within the other, and are soldered together. Hemispherical balls of considerable size, say over 6in. in diameter, can be formed by the process of "raising" under the hammer, in which case die blocks or moulds would be used.—J.H.

Electrical Resistance.—What is the simplest apparatus for measuring the electrical resistance of a metal or a liquid?—J.D.

Answer.—This test is accurate enough for ordinary purposes. The apparatus necessary is a contact key, a galvonometer with a slow swing, an adjustable resistance box, and a small battery (Daniell or Leclanche), of one cell. Put the battery, galvonometer, and key in circuit with the required resistance. Press the key and note deflection on galvonometer. Now replace this required resistance by the resistance box, and adjust this adjustable resistance till the deflection is reproduced, which was got with the required resistance in circuit; then you will have the resistance required.—E. H. Berry.

The Odontograph.—What work contains the best practical description of the odontograph?—J.E.H.

Answers.—(1) A drawing with description as to its use is to be found in "Baker's Elements of Mechanism."—J.R.

(2) If "J.E.H." will look on page 9 of "Pattern Making," by a Foreman Pattern Maker, advertised in *The Practical Engineer*, he will find what he wants.—Cement.

(3) The principle of the odontograph is fully described in "A Practical Treatise on the Teeth of Gear Wheels," by Professor Willis, published by the Brown and Sharpe Manufacturing Company, and sold in England by Chas. Churchill, 21, Cross-street, Finsbury, E.C. Its mode of use is described practically in "Baker's Practical Mechanism," and in "Pattern Making," both published by Messrs. Crosby Lockwood, 7, Stationers' Hall Court, E.C. The scale itself can be purchased of Holtzapffel, Charing Cross, or of Messrs. Spon.

Forced Draught.—Can any of your readers inform me where or how I may get full information as to the results developed by the use of forced draught in marine boilers; which system is used for H.M.'s Navy, and whether there is any reliable work or reference on forced draught?—Velocity.

Answer.—I do not think "Velocity" will find any work specially on forced draught, but a paper was read before the Institute of Naval Architects, in 1883, by Mr. Butler, dealing very fully with the above subject. The system adopted in the Royal Navy is generally the closed stokehold one, and I know of no exception.—J. R.

Hopkinson's Safety Valve.—Could any reader give me a description of Hopkinson's dead weight safety valve, and show how to calculate the weight for different pressures. A sketch will oblige.—S.S.N.

Launch.—Could you or any of your readers inform me as to the thickness of steel plating used in the construction of a launch; the usual length and breadth of same, sizes of Frames, also the best method of constructing the kiel.—W.B.

Launch Building.—Will some reader inform an amateur as to the best method of making the lap joints of small steel launches watertight, also as to the best anti-corrosive paint, as the plates, $\frac{1}{16}$in. thick, are not to be galvanised. Is there any book published on launch building, giving details, &c.—(Scantlings), J.D.

Enamelling Iron.—Can any of your readers give me the names of firms who enamel small iron or steel articles, such as guide bars and mouse-traps used in silk machinery.—Kiel.

Chrome Iron.—I should be obliged for the name of any firm who manufacture chrome iron. I want a quantity of castings containing 15 per cent. of chromium.—Anxious to Trade.

Engine-room Artificer.—What is the pay, amount of service, age and size, and length of apprenticeship, required of an engine-room artificer? Could I join at any time?—G.H.A.

TO CORRESPONDENTS.

F. C.—H. Neill and Son, Newton Bridge, are makers of soap machinery.

G. B.—Messrs. Mackie and Sidley, Liverpool, are makers of ice making machinery.

Constant Reader.—We will show you how to draw a hyperbolic curve next week.

R. M.—"Moulder and Founder's Guide," by W. Overman, price 10s. 6d., can be obtained from this office.

L. B. R.—We do not know what you mean by "square paper." For the breaking strains of beams, etc., see Molesworth, or Anderson on "The Strength of Materials."

Subscriber.—"Screw-cutting, Boring, and Turning," by J. Sheddon, price 1/6. John Calvert, 99, Great Jackson Street, Manchester. Messrs. E. and F. W. Spon, London, publish a small book of "Screw Cutting Tables," by Martin, price 6d., sewn.

Sand Rat.—"The Brassfounder's Manual," by W. Graham, price 2s., London, Crosby Lockwood and Co., will suit you as well as anything. "The Moulder and Founder's Guide," by W. Overman, price 10s. 6d., is a more ambitious work.

B. W. G.—$\left(\frac{L + \frac{1}{2}l}{\frac{1}{2}T}\right)^2 \times s =$ distance the piston has to travel after the steam is cut off; it is a simple transformation of the formula given in Molesworth's Pocket Book, and by reference to the latter you will see how the formula is obtained.

L. B. R.—Gas engines may be indicated in the same manner as steam engines, but in working out the horse power care must be taken to ascertain the number of explosions per minute instead of the number of revolutions as in a steam engine. The power may also be ascertained by means of a brake. Your query is too comprehensive to be answered here. Read Clerk on "The Gas Engine."

E.—In our article on the "Money value of Vacuum," we were not comparing the condensing with the non-condensing engine, but simply showing how important it was in an engine of the former class that great attention be paid to the vacuum. We are aware that the 2lb. spoken of would not be quite all clear gain because of the slightly increased power that would be required to drive the air pump, but we ignored this consideration in order to simplify matters. The deduction to be made on this score would be very slight.

Myra.—It is anomalous to speak of the horse power of a boiler, because this to a large extent depends on the engine. With a modern compound engine using about 20lb. of steam per hour for each horse-power developed, we may count on a well-proportioned Lancashire boiler 28ft. by 7ft. 6in., driveing 300 horse. So that if we multiply the length of boiler by the diameter, and add one-half, we get about the power that the boiler will do. For example, 28 × 7½ = 210, add 105 and we get 315 horse power. If the engine is not so efficient, of course the boiler will not drive this power.

Tenter.—The only way to find the horse-power is to indicate the engine in the usual way, and after the diagrams are obtained, their average height must be found; usually this is done by dividing the diagram into 10 parts, measuring the height of each, adding all together, and dividing by 10. The mean height of the diagrams from the two ends of the cylinder is taken in working out the calculation for horse-power. If the average height has been obtained in inches this must be multiplied by the scale of the spring used to obtain the diagram, in order to get the mean effective pressure in lbs. The rest is mere arithmetic:—Find from a table of areas the area of the piston, or square the diameter in inches and multiply by ·7854, multiply by the average pressure found from the diagram as above, and by twice the stroke in feet, and by the revolutions per minute, and divide the product by 33,000.

One Wishing to Know.—We have no hesitation in saying that the best thing you can do is to send samples to a special oil testing laboratory. The practice of testing oils is a delicate operation, and cannot be conducted with any approach to accuracy by an amateur operator. The common way for an amateur to measure his oil for testing is to dip a wire into the oil, and take the drops he requires as they come, thinking that in this way an accurate measurement is obtained which will enable him to fairly test one oil against another. As a matter of fact such a test is useless, the drops of the same oil so obtained varying to a considerable extent, and different oils to the extent of 40 or 50 per cent. With a glass dropper drawn out to the finest needle point, two successive drops obtained with the greatest care cannot be got to weigh alike. This is one difficulty in oil testing which leads us to think that amateur oil testing is very unsatisfactory. Of chemical tests there are many, some rough and ready; but here, again, everything is against the amateur, and when results are obtained, experience is necessary to show the exact value of them. Several books have been published on this subject which afford much valuable information, and the enquirer may perhaps derive a hint or two from an article in another part of this issue.

MISCELLANEA.

Contract for Rifles.—The Servian Government have signed a contract for the purchase of 150,000 repeating rifles of the Schulhoff pattern. They are to be manufactured in America, and must be delivered before the end of the year.

New Spirit Level.—A spirit level is a new American invention. It consists of a circular tube partially filled with spirit or other proper liquid, mounted in connection with a semicircular graduated plate, whereby the instrument may be used for obtaining level or perpendicular lines or intermediate angles.

House Lighting by Electricity.—Electric lighting from house to house from a public centre is making considerable progress in London, and a double cable of stout wires for this purpose has just been laid under the footpath in Kensington Palace Gardens, one of the finest roads in the west of London, where the houses are all large, rented at from £500 to £1,500 a year, and all upon Crown land.

Protection of Boiler Tubes.—In order to prevent the rapid burning out of the front ends of boiler tubes, a corrugated shield or inner cover for each tube has been devised by two Americans. This shield, which may also be made with a plain surface, is to be applied in the end of each tube at the point of each connection with the fire-box of the boiler. It is removable, and can be easily replaced when destroyed.

Transmitting Power.—A method of transmitting power without shock between bodies moving at different velocities, has been invented by a M. Raymond Snyers. His plan consists in transmitting the power through a metallic brush. Thus in applying this principle to the transmission of driving power to a machine, a disc fitted with segmental brushes, is slid along the shaft so that its fibres come in contact with radial projections on a second disc. Although contact is made instantaneously, yet, owing to the yielding of brushes, the machine is started gradually and without shock. The inventor proposes by a modification of this plan to cause a locomotive running at full speed to operate signals, or shut off steam automatically.

The Panama Canal.—The fortunes of the Panama Canal scheme are approaching a perilous crisis. Some two months ago M. de Lesseps addressed a note to the French Government requesting permission to issue lottery bonds for the sum of 565 millions of francs—nearly double the original amount of the capital—which he declared was requisite for the completion of the Canal works. The Cabinet have decided not to grant the required authorisation.

The Owen's College Engineering Society.—At a meeting of this society, held on Tuesday night, Prof. Osborne Reynolds in the chair, a paper was read by Mr. Maxwell, on the Manchester Exhibition Buildings. The author dwelt at length on the numerous devices that were adopted in the construction of the building, for minimising the first cost, and for using such material only as would be saleable after the buildings were pulled down. The paper was listened to with great interest.

The Forth Bridge.—The nineteenth quarterly report of inspection of the Forth Bridge Works, states that up to the present date about 566,500 cubic feet of granite have been delivered, and 562,000 cubic feet have been set, while about 111,600 cubic yards of rubble masonry and concrete work have been built. The whole of the bottom junctions for Bays No. 1 are practically complete in the yard. The fitting of all the bottom junctions for Bays No. 2 is in hand, and the whole of the top junctions for Bays No. 1 are well advanced. Eight fatal accidents occurred to workmen during the quarter just ended.

Steel Direct from the Ore.—A new process for producing iron and steel direct from the ore has been brought out in Russia, which, from our Consul's report would appear to be a great success. Under the new process iron ore, after being submitted to the smelting processes, is taken direct from the furnace to the rolling mill, and turned into thin sheets of the finest charcoal iron. At present the process has only been commercially applied with charcoal fuel, but experiments are stated to have shown that equal success can be obtained with coke. The secret of the process lies in the construction of the furnace, which is said to be simple and inexpensive.

Curious Injector Stoppage.—*The National Car and Locomotive Builder* humourously describes a curious stoppage of an injector, which refused for a long time to work, and after the whole shop was excited about the injector, that refused to obey the laws of nature, the machinist finally discovered that the delivery-pipe had a soldered joint in the middle which had got loose inside, and turned up toward the centre enough to break the force of the water when forced at high speed by the injector, but not sufficient to prevent the water from passing freely enough when it was merely poured into the pipe. As there was a bend at each end of the pipe the existence of the obstruction could not be seen.

Electric Traction on the Underground Railway.—The Metropolitan Railway Company have concluded an arrangement with the Electric Traction Company for the experimental running upon a section of the railway outside the circle of an electric locomotive of the same power as the present steam locomotive. The Electric Traction Company stipulate that should the experiment prove an advantageous and economical method for working they are to have the option of entering into an agreement for working the railway by electricity for a term of five years at a rate per train mile, to be agreed upon, such rate not to be in excess of the cost of working by means of steam locomotives.

King's College Engineering Society.—At a general meeting of this society, held on January 17th, Mr. Gask gave his presidential address, taking for his subject a review of engineering in general, during the past year. The various public works completed and in course of construction during the year were discussed; among the former being the Tay bridge, the bridge over the river Hooghly, and the Hammersmith bridge, and among the latter the Forth bridge and the City of London and Southwark Subway, descriptions of the mode of construction being given. Details of the working of the Southwark subway were received, and the advantages pointed out of the cable system of traction over that of steam locomotives. The author then touched lightly on the state of the Panama Canal, pointing out the difficulties to be overcome, among others being the financial difficulty. Among marine matters the *City of Paris* and the *City of New York*, of the Inman and International Company, are in course of construction. The author then stated that the works at Birmingham for the public supply of compressed air to the town, in course of construction by Professor Robinson, were nearly completed, and were expected to be in operation next April. The state of the river Thames was discussed, and the various plans for purification, among which was mentioned Mr Walham Webster's new method of deodorising and separating the sludge by electricity. In electrical matters Mr. Gask described the process of electric welding, and showed the advance made by electricity as a motive power, mentioning the large electric locomotive constructed at the Rhode Islands Locomotive works. In conclusion, the author spoke of the advantages of cable tramways in towns.

SELECTED PATENTS.

APPLICATIONS FOR LETTERS PATENTS.

January 13*th*.

537 Fastener for Window Sashes, E. J. Tonks and G. Burden, Birmingham
538 Cartridge Cases, M. Mullineux, Manchester.
540 Electric Balloon Carriage, T. Needham. Huddersfield.
541 Steam Cranes, J. E. Gill, Leeds.
542 Safety Fuse, F. J. Shand, Glasgow.
543 Sewing Machine, F, W. Rawstron. Bradford.
545 Chaff-cutters. C. Turner, Nottingham.
546 Fastener for Windows, C. C. Wright, London.
549 Dynamo Generators and Motors. J. Blackburn.
553 Safety Coupling. R. L. Johnson, and A. Boots, Eastbourne.
554 Chimney Cowls, D. Burns, Carlisle
559 Supporting Sliding Windows, H. A. Ivatt, London.
560 Projectiles, A. E. Barthel and J. C, J. Möller, London.
578 Speaking Tubes. F. Moor, London.
579 Adjustable Eccentric, S. Walkden, London.
580 Appliance for Reversing Rolling Mills, H. Sack, London,
584 Electric Railways, W. L. Madgen. London.
585 Paper-Making Machines, H, Hoeborn, London.
587 Casting Metal Ingots, W. Becker, London.

January 14*th*

591 Belt Fastener, T. C. Sargeant, Northampton,
593 Compound Locomotives, A, Johnson and W P. Green.
594 Steam Generators, B. H. Thwaite. Liverpool.
597 Pantagraph Engraving Machine, G. Moulton, Manchester
600 Hot Air Engine, J. Y. Johnson, Middlesex. (L. Genty, France).
601 Engine Valve Gear S. Hallam, H. Stevenson, J. Webb, and F. W. Ewen, Manchester.
606 Filters, W. A. Nicholl, Halifax.
619 Sewing Machines, E. Böttcher, London.
629 Calculating Machines. M. Mayer, London.
630 Valves, W. K. Anderson, London.
633 Dynamo-Electric Machine, C. Coerper, London.
638 Punching and Shearing Machines, C. W. Pinkney, Middlesex.
639 Gas Punching Machine, C. W. Pinkney, Middlesex.

January 16*th*.

644 Rope Wheels, F. W. Wetherell, Stockton-on-Tees.
650 Carriage Couplings, J. Crabtree, Birmingham,
651 Edge-Planing Machines. J. B. Parker, Glasgow.
652 Spigot and Socket and Flange Pipes, F. Herbert, J. E. Jordan, and C. G. Jordan, Newport.
655 Coal-getting Machinery, S. S. Skipton and O. Y. Rhodes, Halifax.
656 Thermo-dynamic Engines, J. Hargreaves, Liverpool.
658 Alarm Valves or Taps, J. O. Jackson, Manchester.
659 Pneumatic Speaking Tubes, H. P. Dunn, Buckinghamshire.
660 Rotary Pumps and Engines, J. W. Briggs, London. (W. Barber, United States).
666 Safety Fuses, W. Bennets. London.
667 Fusible Cements. M. Kackay, Old Kent Road.
671 Lock Nut, R. Clay, Middlesex.
675 Pistons, D. J. Morgan. Middlesex.
680 Snap Hooks, J. F. Sears and H. E. Kelley, London.
683 Anti-corrosive Composition, W. C. A. Holzaffel, Newcastle-upon-Tyne.
686 Casting Metal Ingots, H H. Lake, London, (J. Illingworth. United States.)
688 Gas Engine Igniting Apparatus, C. D. Abel, London. (The Gas Motoren Fabrik Dentz, Germany.)

January 17*th*.

695 Corrugated Boiler Flues, H. P. Fenby, Farnley.
697 Valve Gear of Oscillating Engines, W. Sisson, London.
701 Rotary Motion, H. A. Stuart, Bletchley.
703 Continuous Ratchet Brace, G. Oldfield, Leeds,
715 Gas Producers, J. Noble, Grosvenor Terrace, Middlesbro'-on-Tees.
716 Regenerative Furnaces, J. Noble, Grosvenor Terrace, Middlesboro'-on-Tees.
719 Mining Machines, A. J. Boult, Middlesex. (R. B. Westbrook, United States.
721 Roller Mills. W. P, Thompson, Liverpool (J. A. McAnulty, U. States)
724 Marking Strip for Boiler Makers, A. Higham, Chatham.
725 Type-Writing Machines, M. Hearn, Hampstead,
731 Tip Waggons, W. H Rickard and T. J. Rickard, London,
733 Channel Bar for Girders, J. Sanderson, London.
735 Tool Cabinet and Bench, R. Melhuish, London.
746 Manufacture of Pulleys, A. B. Perkins, London.

January 18*th*.

763 Wire Rolling, W. Watts, Sheffield.
764 Hydraulic Pressure-testing Apparatus, G. Munroe, Liverpool.
768 Bending Iron or Steel Bars, R. Duncan, Glasgow.
770 Bolts Rivets and Screws, T. Woodhead. Bradford.
773 Triple Expansion Engines, P. M. Justice, Chancery Lane. (M. T. Davidson, United States.)
775 Steam-Wheels as Motors, J. Willis, Sheffield.
783 Gas Enginss, J. Smith, Manchester.
784 Automatic Sprinklers, T. Dutton, Manchester,
787 Forming the Heads of Nails, F. Myers, Liverpool.
790 Rotary Engine, John Blum, London.
793 Mitre Planing Machines, G. T. Webster, London.
810 Screw-Spanners, J. Chatwin, Middlesex.
818 Disappearing Mountings for Guns, W. Anderson, Westminster.
822 Power Storing Brakes, H. J Haddon, London. J, F. Reimer. F. C. Reimer, and P. Koenecke, Germany.)

January 19*th*.

836 Operating 'Corlis' Valves, W. Sharples, Manchester.
842 Feed Valves, T. Dale, Kircaldy.
844 Compound Steam Engines, Herbert Lindley, London.
850 Wheel Guard. J. S. Tulley, Islington,
853 Transmitting Motion, C. A. Thuron and V. L. M. Renard, London.
855 Guards for Revolving Shafts, W. Fox, London.
866 Permanent Way of Tramways, G. Lingley, Stratford.

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We cannot undertake to return rejected manuscripts or drawings unless accompanied by a stamped and directed envelope.

Contributors are requested to write on one side only of the paper. Sketches should be sent on separate sheets.

TO ADVERTISERS.

Advertisements intended for insertion in the current issue should reach us on Wednesday morning at the latest.

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NOTICE TO NEWSAGENTS AND SUBSCRIBERS.

Numerous complaints having been made to us by Subscribers of the difficulty they experience in obtaining copies of the *Practical Engineer* in certain districts, we have to state that the Journal can be obtained by any Newsagent through the ordinary Trade channels, and no difficulty should therefore exist in obtaining copies by order of any Newsagent.

For the information of the Trade, we may state that copies can be obtained from either of our Offices in London or Manchester, or from any of the following wholesale houses, who are also supplied with Contents Bills for the use of the Trade:—

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GEORGE BROMBY, 26, Charles Street, Hull.
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&c., &c., &c.

SOME REMARKS ON PISTON FASTENINGS.

(CONTRIBUTED.)

A LARGE percentage of steam engine breakages are due, originally, to lack of proper attention to some detail in their mechanism. As the piston is one of the most important working parts of a steam engine, and beyond the reach and attention of the attendant under working conditions, it is of the utmost importance that its fastenings should receive strict attention. It is the writer's intention in this short article to make a few practical remarks on some of the most common methods of piston fastening now adopted in large engines, as failure in these points is very often the cause of so many pistons breaking or coming loose on the rods, involving great damage to the engine, and much loss of valuable time.

Of the numerous methods in use of securing the piston to the rod, the two most common and general are, the cottar through piston and rod or, a nut at the end. In each case the piston end of rod is swelled and tapered for a length equal to the depth of piston and to suit the conical hole in same. The rod should always be a first-class fit, and have a good bearing in the piston, to ensure which great care is required of the turner. As a rule the practice in first-class work is to make the conical end of rod bear hard for some distance at either end of hole, and to barely touch at the middle. If the bearing is hardest in the middle, the rod has a tendency to burst the piston when forced or drawn up by the cottar or nut. Split cottars are very much in favour with practical mechanics, wherever applicable, for securing rod to piston in large engines of all kinds, with cylinders say of 20 inches and upwards, care being exercised in making them a good fit in the cottar holes. The main points to be taken into consideration in the proportioning of cottars are, that they shall be large enough to resist the shearing and bending without diminishing the net section of the rod end below the area required to resist tensile strains. One of the chief objections to cottars is, they generally fail by bending and allowing the rod to come loose—a case of shearing the cottar very rarely occurring; therefore it is of the utmost importance that they should be well fitted into their places so as to get good bearings.

A nut screwed up against piston on the rod end, and prevented from working loose by the insertion of a split pin, is claimed to be preferable to a cottar, as it gives a larger area to resist tensile stresses, and less risk from bad workmanship. Granting this to be so, experience shows they are not so satisfactory as cottars after all. An important instance shewing how unreliable nuts are for securing piston to rod came under the writer's notice some time ago. It was in the case of a new pair of large horizontal colliery winding engines, fitted with pistons of the ordinary type, known as "metallic ring," secured to the rods by large nuts prevented from working loose by split pins inserted in the usual way. When the engines had been working about two years, the cylinders were opened in order to tighten up the piston rings, and it was discovered that the nuts on both pistons were burst open, nearly in the same way, by cracks extending from the thread inside to the flats outside, and the whole security of keeping piston and rod together depended on the split pins preventing the nuts from working loose, which would be an easy matter under those circumstances. It appears to the writer to be almost impossible to form any sound conclusion as to the cause of such failure, the most reasonable being that the nuts were fitted too tight on the rod, and when screwed up a great initial strain was produced, which culminated in the bursting owing to difference of expansion in nut and rod when heated under working conditions; or it may be that owing to the ordinary way in which the nuts are forged, the welds were defective, and they gave way under the great strain produced by the before-mentioned causes. Perhaps some readers of this will have experienced similar cases; if so, their opinions, no doubt, will be welcomed by all interested. In marine work it is almost the universal practice to use nuts for securing the piston to the rod. There is reason to believe the method is not altogether satisfactory, as pistons have been known to come loose on the rods with disastrous consequences. On investigating the cause of an accident of this kind, it was ascertained that the thread of screw upon the rod was corroded away, while that of nut remained good. The owners, warned by this, had the piston fastenings of some of their other steamships examined, and found many of them defective in the same way, the screw thread of rod, to a more or less extent, having corroded away, while that of nut was good. It is not the writer's intention to advance any theory as to the cause of such corrosion, but merely to bring it to the notice of interested readers, shewing the unreliableness of a nut for such important fastening.

One other fastening that may be referred to is that by which the junk ring is attached to the piston. The method adopted, nearly always the same, is by a number of bolts passing through the junk ring and screwed into the body of piston, or either into gun metal nuts fitted in recesses provided for the purpose in piston—various locking arrangements being in use to prevent these bolts slacking back, in consequence of the vibration of the piston. The action of high-pressure steam, mixed with the cylinder lubricant, fat and oil, not always free from acids (this remark does not apply to properly refined mineral oils), in corroding away screw threads in cast iron, makes the former practice very unreliable. As a rule in first-class practice the pistons are always fitted with gun metal nuts to receive the junk ring bolts, as a security against this dangerous corrosion of the thread. Indeed, it is surprising to find the number of patent pistons at present in the market minus these gun metal nuts. The reason is obvious, makers are able to offer them so much cheaper. Steam engine users should take warning that if such pistons are a trifle cheaper in first cost, they are daily open to failure, involving great damage to the engines, while a little extra cost in getting a first-class piston is a security against such danger. An important case shewing the truth of this claimed the writer's attention not long ago. It was in the case of a new compound inverted tandem engine, driving some rolling mills, and made by the lowest tenderer. When the engine had been working some eighteen months or so, a break-down occurred, and, upon investigating the cause, it was discovered that the piston of high-pressure cylinder was not fitted with gun metal nuts in the usual way, but the junk ring bolts were screwed into holes drilled and tapped in the cast iron body of piston, the threads of which were completely corroded away, nothing preventing the junk ring, &c., coming loose, with the result that the piston was totally destroyed, a cylinder cover smashed, and much other damage done, better imagined than described.

A perusal of the foregoing may be of some interest, and a warning, especially to inexperienced steam engine users, to give careful attention to these details, to guard against similar accidents, and to avoid worthless pistons.

CHAMBERS OF COMMERCE AND THE BOILER REGISTRY BILL.

At the time Lord Stanley, of Preston, introduced the Bill for the Registry and Inspection of Steam Boilers, which was read a second time in the House of Lords, on August 15th last, we referred (see *Practical Engineer*, vol. i., page 367) to some of the difficulties likely to be experienced by steam users and others, should the Bill become law, and anticipated that it would be likely to meet with considerable opposition. Since that time the subject has been discussed by Chambers of Commerce and other public bodies in some of the principal manufacturing towns in Lancashire and Yorkshire; and we published in *The Practical Engineer* of Nov. 18th (vol. i., page 511) an account of the introduction of the subject at the meeting of the Council of the Oldham Chamber of Commerce in November last. Two meetings of the Chamber have since that time been held, at which lengthy and animated discussions on this subject have taken place. That a Bill which is calculated, if passed in its present form, to put serious restrictions on a steam user's business if its provisions are strictly enforced, should meet with strong opposition from many steam users was only to be expected; but we do not remember an instance where any public body has taken up such an uncompromising attitude towards it as has the Oldham Chamber.

The Chairman (S. R. Platt, Esq., Mayor of Oldham), at the adjourned meeting in December last, remarked that he thought the Bill absolutely unnecessary, and considered it would have a tendency, if passed, to inflict great hardship on boiler owners. He could understand the Bill if there was an urgent necessity for legislation in consequence of boilers being blown up every day, but he thought the risk of boiler explosions was getting less and less every day, because there was more intelligence both amongst users and constructors of boilers at the present time than had ever been known before, and the material used in the construction of boilers was vastly superior, hence the risk of danger from these occurrences, which was never very great considering the number of boilers in use, was getting a less and less quantity. There were already several boiler institutions, and for a very small sum per annum steam users could have their boilers inspected as efficiently as they could ever possibly be done by Government or other supervision. He did not see the necessity for this most stringent Bill, which he looked upon as a "piece of grandmotherly legislation of no practical use, and got up simply for the purpose of making a sound." The following resolution was, after an animated and lengthy discussion, ultimately adopted, with only one dissentient, viz.:—

"That the Oldham Chamber of Commerce most strenuously oppose the Boiler Registry and Inspection Bill, 1887, which it considers unnecessary, as shown by the rapid diminution of accidents which has taken place during the last few years, and as only likely to further embarrass trades already sufficiently harrassed by Parliamentary enactments, and would call attention to the Boiler Explosions Act, 1882, the powers under which already conferred upon the Board of Trade, if put in force, are amply sufficient to act as a safeguard against accidents, and as a deterrent to carelessness on the part of owners of boilers."

A copy of this resolution was sent to the Board of Trade, and notice was given by the Oldham Chamber of Commerce to introduce the same resolution at the Annual Meeting of the Association of Chambers of Commerce to be held in London during the present month.

The Board of Trade, in acknowledging receipt of the resolution, asked to be favoured with the views of the Chamber with respect to the putting in force of the provisions of the Act of 1882, and at the Annual Meeting, held in the Town Hall, Oldham, on Friday last, the 27th ult., the President, S. R. Platt, Esq., Mayor of Oldham, in the chair, the Secretary was instructed to reply as follows:—

"I beg to acknowledge receipt of your letter of the 3rd inst., and in reply to your statement that 'the Board of Trade would be glad to be favoured with the views of the Oldham Chamber of Commerce, with respect to the putting in force of the provisions of the Boiler Explosions Act, 1882,' I am directed to say, that the Oldham Chamber of Commerce is not aware that in any single case has a Formal Investigation been held under the Boiler Explosions Act, 1882 (see Section C, Subsections (3) and (5); also Section 7 of that Act), although there is reason to believe there have been cases of boiler explosions which have occurred by reason of culpable negligence. And the Chamber is of opinion that in every case of a boiler explosion, a full report of the Preliminary Inquiry and Formal Investigation should be immediately published in the newspapers of the district in which the explosion occurred, giving the opinion of the

Board of Trade engineer as to the cause of the explosion investigated. Such report, and the unenviable notoriety caused by the publication of every case would, in the opinion of this Chamber, act as a sufficient deterrent to carelessness or neglect, and fully serve the objects of the proposed Act."

It may be mentioned that the Blackburn Chamber of Commerce has declared in favour of the Bill with some amendment or modification of Clause 10, which empowers the Board of Trade to cancel a steam user's certificate without consulting anyone, or giving the power or opportunity of having the boiler surveyed again.

The Oldham Chamber of Commerce is composed largely of users of steam power, and there are probably more steam boilers in Oldham and district than in any other district of equal area in the world, hence the decision arrived at by this body will be viewed with great interest, and will doubtless have considerable weight and influence in other quarters.

CAST IRON MANTELPIECES.

Cast iron as a material for construction and ornamentation of houses is becoming rapidly more fashionable. In most of the newest London houses, in the fashionable quarters, cast iron mantelpieces and overmantels are being adopted. The carving and general appearance of wood is well imitated in these most elaborate castings, so that at first sight it is easy to mistake them for wood. The castings include bevelled frames for mirrors without number, and as they can be supplied at about a third the cost of the mantelpieces carved in hard wood, it is very likely they will be largely adopted. The change in fashion thus indicated will be welcomed by ironmongers as another channel for brightening the prospects of the iron trade.

HEALTH IN WORKSHOPS.

A healthy workshop is a great boon to the men employed in it, and is a factor that, other things being equal, will influence very considerably the amount and kind of work turned out. Yet it can hardly be said that employers, as a rule, realise the importance of providing the healthiest workshop possible, but often rest contented if there is the merest apology for a roof on the one hand, or the stuffiest and most badly lighted workshop on the other. Workmen, as a rule, do not care to be exposed to the weather in the depth of winter, nor do they appreciate being excluded from a breath of fresh air in the height of summer; and under such circumstances it is manifestly impossible for them to put forth their best energies, or to produce the best work of which they are capable. Any employer who has a workshop of the kind here indicated, would do well to study Mr. Corbett's paper, read before the Manchester Association of Engineers, extracts from which are printed in another column of this issue. They will see that from the lowest motive, that of self interest, it pays to attend to the neglected subjects of ventilation, heating, lighting, sanitation, &c., and, without considering it from a humanitarian point of view, we may expect them to improve their workshops on this ground alone. The suggestion of providing proper warming and boiling appliances, as well as a dining room, in large workshops, and periodicals for perusal during meal hours, we commend to those who usually look upon expenditure of this kind as sheer loss; we believe that it is rather like seed sown in the ground which will soon spring up and bear fruit in the shape of better work and more of it. A well ventilated, well warmed, well lighted, and well fitted workshop in every respect will attract the best workmen, and in that way alone the employer instantly reaps an advantage not enjoyed by his neighbours; and all this can be done at a very little cost. We trust that Mr. Corbett's paper will be widely read, and that its lessons will be as widely put into practice.

TRANSMISSION OF POWER.—I.

The methods employed for the transmission of power from the prime mover to the point of application vary much, but are mostly governed by the distance between the prime mover and the point of application, and also by the character of the work to be performed.

The principal methods are by couplings, shafting, spur gearing, leather and other belts, and cotton and hemp ropes for short distances; water, compressed air, and wire ropes for medium distances; and electricity for long distances.

The writer proposes to give a series of notes, from time to time, setting forth such particulars of the different methods of transmitting force, as may be practically useful to the working engineer.

BELTS.

M. Leloutre, in a communication made to the French Society of Civil Engineers in 1878, gives the results of extensive experiments in reference to—

1. The elongation, elasticity and breaking strain of driving belts made of leather, india-rubber, webbing and canvas.
2. The slipping of belts and cords.

He found the breaking strain to be very different, according to the mode in which the load was applied, and his experiments shew that if under a continuously increasing load a piece of good leather be broken in an hour by a strain of say 4,300lbs. per square inch, the same piece will barely carry two thirds of that strain if five or six months be spent in breaking it by an increasing load alternately put on and taken off. The experiments further shewed that a long time is required for any belt to stretch as much as it is capable of doing under a given tension.

Broken pieces, after having been subjected for months and years to tests, recovered their original length, after several months' rest, and the strength was not in any way affected by successive fractures.

The elongation produced by a tensile strain upon leather, india-rubber, webbing, and canvas, is in no way proportional to that strain, but always increases less rapidly than the tension, or, in other words, the modulus of elasticity rises as the load increases.

In ordinary leather the maximum resistance to stretching is met with at a strain of about 850lbs. per square inch; in india-rubber and webbing it occurs at a rather lower strain, and M. Leloutre states that it is evidently advantageous that the working strain on a belt should be fixed as near as possible to that at which the maximum resistance to stretching occurs, viz., 700 to 800lbs. per square inch of section. This is fully three times as great as the tension generally recommended by many engineers, which ranges from 200 to 300lbs. to the square inch.

EDISON'S NEW LABORATORY.

Edison's new laboratory, now in course of erection at Orange, New Jersey, will comprise a main building 275ft. long by 57ft. broad, surrounded by four smaller structures each 110ft. by 17ft. The central building is to be three storeys high, the ground floor containing heavy machine tools, whilst the second will be fitted up as a photographic studio and drawing office, and the third will be supplied with the apparatus necessary for experiments in electricity. Power will be supplied from two steam engines and four dynamos. Of the minor buildings one will be almost exclusively reserved for magnetic experiments, and iron will, therefore, not be used in any part of the building, its place being supplied by copper, brass, and lead. The other buildings will contain chemical and metallurgical laboratories, and a carpenter's workshop.—*Engineering.*

BOILER SETTING.—I.

In few matters of minor importance has so much general all-round progress been made in recent years as in the improvement which has taken place in the modes of setting steam boilers. Judging by the manner in which many old boilers are found to be seated, one would imagine that boiler setters and bricklayers at one time must have had the idea that as much brickwork must be placed in contact with plates as possible, and that heavy masses of brickwork at the seatings were essential to stability; and hence boilers were frequently almost completely enveloped in brickwork and the flues made as small as possible.

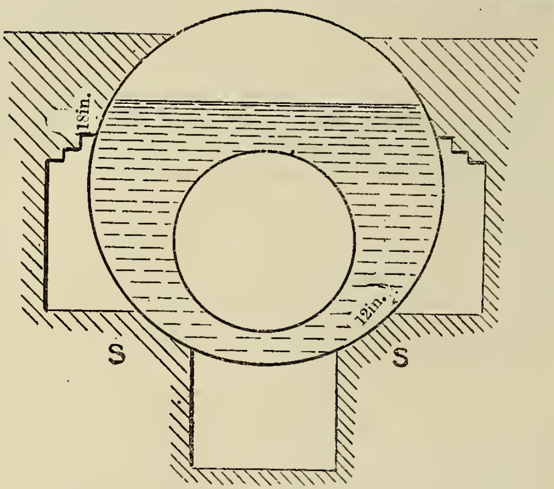


Fig. 1.

Unfortunately in some places even yet there is much misconception in this respect, as only a week or two ago the writer came across a boiler newly set as shown in fig. 1, stated to be from the plans of an architect, with the side wall seatings nearly a foot broad, and a heavy mass of brickwork, fully 18in. deep, on each side of the upper portion of the boiler, above the crowns of the side flues. Apart from occasional instances of benighted ignorance of this kind, however, it may be stated that it is now becoming more generally understood and recognised, even in many out of the way country places, where knowledge is frequently so slow to penetrate, that a minimum thickness of bearing surface only

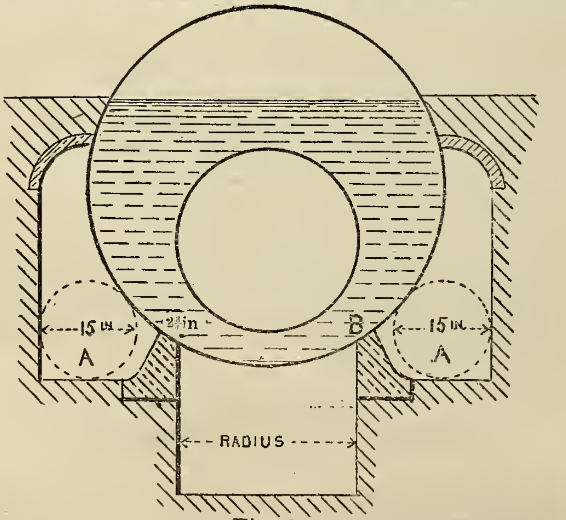


Fig. 2.

should be allowed, where the boiler plates are in contact; and instead of ordinary bricks, which are porous and readily absorb moisture, hard tile blocks should be used, which both cover up less of the heating surface of the boiler, and are not so liable to harbour and secrete corrosion. It may be stated as a general rule that for boiler seatings, a supporting width in transverse section of not more than one inch per foot diameter of the boiler is necessary as a maximum, so that for a boiler, say 5ft. 6in. diameter, such as shown in fig. 1, the seating blocks in contact with the plates need not have exceeded say 2¼in. on each side, and we have shown in fig. 2 how the boiler should have been seated in accordance with the best practice

Reverting to fig 1, it will be seen that with a boiler 20ft. long, there is a diminution in the heating surface at the seatings of something like 31 square feet altogether, equal to (taking 10 square feet of heating surface per N.H.P.) something over three nominal horse power in a boiler this size.

In addition to the gain in heating surface, however, a little consideration will show that the mode of seating shown in fig. 2 possesses a number of other advantages over that illustrated in fig. 1. The side flues in fig. 2 are much more capacious, and consequently give much better draught. When seated as in fig. 1, the deposits of soot, flue dust, ashes, &c., at once begin to accumulate against the boiler sides, still further continually diminishing the heating surface, and impairing the draught; whereas with a correct seating the deposit will fall away from the boiler sides, and there is ample room for a large accumulation in the bottom of the side flues before the shell sides are covered, or the capacity of the flues is materially reduced. The flues consequently may be cleaned at less frequent intervals; there is more room for cleaning and inspection, and should there be any damp about the flues, it would be much more likely to be absorbed by the brickwork, and conveyed to the boiler plates in the seating of fig. 1, than in fig. 2. We have known many instances where boilers have been set in low and damp situations, such as below the level of a river or canal, where the flue brickwork has been quite moist, but where the damp has never extended to the plates on the seatings, when the latter have been surmounted by hard tile blocks, with narrow bearing surfaces, in contact with the plates as shown in fig. 2.

Not only at the seatings, however, but at the crowns of the side flues should hard non-porous tiles be used. In fig. 1, it will be observed there is a depth of brickwork above the side-flue crowns of something like 18 or 20 inches, and although this does not rob the boiler of valuable heating surface, as at the seatings, it both increases the liability to external corrosion, and adds to the difficulty of detection. When boilers are entirely covered with brickwork, as many still are, instead of having a good non-conducting porous composition covering on the top, slight leakage will sometimes take place at a joint of one of the fittings, and will often not be detected until the moisture resulting from it has extended over a considerable area, through the absorbent porous brickwork, and much damage has been done by the external corrosion resulting from the damp brickwork in contact with the boiler plates; before being discovered, many boiler explosions have resulted from this cause.

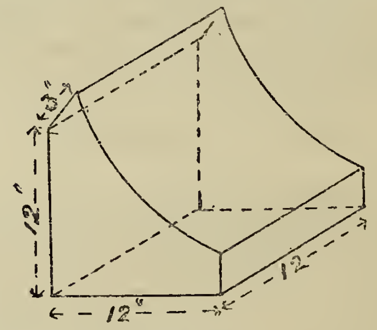


Fig. 3.

In *The Practical Engineer* for November 11th, 1887, p. 502, referring to an explosion which took place from corrosion on the side wall seating, we pointed out that seating blocks of fire clay could be specially made adapted for any size of boiler. Blocks are frequently used with narrow bearing surfaces, but much too shallow, and the important point is that they should be of sufficient depth, otherwise where boilers are of comparatively small diameter, there is not sufficient room or depth in the side flues. We have shown, in fig. 3, a block, which is 12in. deep, at inner vertical side, next boiler, by 12in. long, and 3in. thick at its outer edge, and having a bearing surface of 3in. where in contact with the boiler plates. Such a block may be used with confidence for almost any size of boiler, and we believe blocks of the size and section shown are now always kept in stock by many of the leading makers of fire-clay goods, such as Messrs. John Knowles and Co., Wooden Box, near Burton-on-Trent; J. R. Fyfe and Co., Shipley Fire Brick Works, Shipley, Yorkshire, and others. The latter firm were awarded a first-class award for boiler seating blocks and flue covers at the Royal Yorkshire Jubilee Exhibition, held last year at Saltaire. We may add that ground fire clay should be used in all cases to cement the fire bricks and blocks used in setting steam boiler as lime mortar, if in contact with the plates, corrodes the iron. Fire clay is quite harmless to boiler plates, and will stand heat and set well.

SLOTTING MACHINE BAR.

A writer in the *American Machinist* sends the following design for a slotting machine bar intended to relieve the tool of pressure against the work on the return stroke. The lower end of the bar is formed so as to allow a rectangular slot to be cut through it. In this slot is placed the tool holder F, which works on the pivot B. In this holder the tool A is secured by means of the set screws E E, the heads of which project into the slot D cut in the end of the bar C. The tool holder A rotates slightly around the pivot B at the commencement of the upward stroke, and when completed the tool is at once pressed into its correct position for cutting by the spring G, and is held in readiness for the downward movement of the bar.

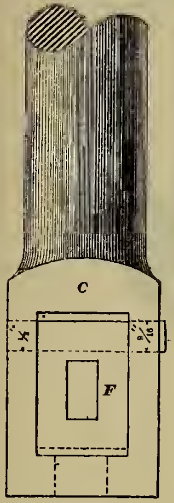


Fig. 1.

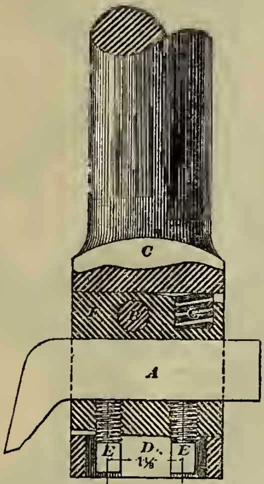


Fig. 2.

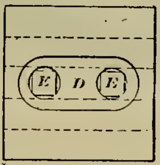


Fig. 3.

ECONOMY OF HEALTH IN WORKSHOPS.—I.

On Saturday, Mr. J. Corbett read a paper before the Manchester Association of Engineers on the above subject, from which we give the following extracts:—

The broad title of my subject would allow of too wide a range for the compass of one paper, so I take it in the more limited sense of "The Economy of Health in Engineering Workshops," but of course many of my remarks will apply almost equally to workshops for other trades.

During the time that a workman is learning his trade, or any special branch of his trade, he is a less profitable employé than after he has fully learned it. Therefore, as each one must needs pass through the learning stage, the more years of working life that he is afterwards available for, the more profitable on the whole and on the average is his life, and economy of health tends to give longer life. Again, after the man is in full work, it is of the utmost importance that he should be regular in his attendance, or else his work and the costly tools used in his work may lose time by his absence, and economy of health tends to give more constant health and less loss of time from sickness. More than this, a healthy workman is stronger, more clear headed, more ready and quick in action, than an equally good man in depressed health, and these are valuable qualities that an employer may have at his service without paying higher wages. Finally, I would argue that the healthier workman is the more contented workman, that the healthier workshop is the more comfortable workshop, and therefore that a workshop which gets a repute among workmen for being more comfortable than others, and filled with more contented men, will always be sought after by the most thoughtful and valuable hands, so that the employer can have his choice of men without paying more than standard wages.

Turning now to the practical problems to be solved, I will divide them into four departments:—

1. Ventilation and heating.
2. Lighting by daylight or artificial light.
3. Water supply, dining rooms, etc.
4. Sewering and waste appliances.

VENTILATION AND HEATING.

There are few departments of engineering workshops where men are too overcrowded for due healthiness, but, as it is possible in rooms for small machines, I will point out that each man should have at least 25 square feet of floor area, and at least 400 cubic feet of space, for comfortable ventilation. The quantity of fresh air required per man per hour is not less than 1,000 cubic feet, even in cold weather and with inactive employment, and four times to ten times this amount is required for laborious work in warm weather. Indeed it would be difficult to assign limits to the stream of fresh air eagerly welcomed by hard working men in hot weather. In arranging for the ventilation of a workshop we may, as the simplest course, make openings in the walls, windows, roof, etc., depending on the wind and on the rise of temperature in the workshop, to cause the requisite currents in and out. But the wind is utterly variable and unreliable, and as to the rise of temperature in the workshop, it will be highest above the open air temperature in cold weather when ventilation has to be reduced, and will be almost the same as the open air temperature in warm weather, when ventilation should be increased. So mere inlets and outlets to the open air, even when fitted with means of opening and closing them, afford only inadequate and contradictory means of ventilation. It naturally follows that all cowls and whirligigs depending on the wind for their action are most active when least wanted, and least active when most wanted. Indeed, I think there are very few mechanical appliances by which the public is more humbugged, and more completely sold, than the various wind whirligig ventilators which are successfully puffed and advertised by many so-called ventilating engineers. One important rule as to outlet ventilators is to have only one for each room, unless for rooms of great size; because if there are two or more outlets, some of them will at times act as inlets, and thus reverse the intended currents. No rule can be given for the size of open outlet ventilators, except that already indicated, that at least 12 square inches per man should be provided, and for hot work much more; the inlets being of similar area. Air inlets should be as numerous as circumstances permit, and arranged to disperse their draughts as widely and gently as possible. If no men work close to them, the best plan may be a simple flat board or plate fixed a few inches off the wall, so as to turn the draught out on all sides. Where external appearance is no great object, the best weathering for an air inlet is simply a piece of glazed tile pipe built with a slight outward slope into the wall, and projecting a couple of inches outside; but the most efficient and neatest arrangement, where available, is to have a projecting shield, with openings on all sides of about 1½in. to 3in. width, not liable to get choked with dust; the shield protecting the inlet from gusts of wind. In dealing with a very broad room with other rooms over it, the equalisation of the air can best be effected by having the air outlet at the centre, and the inlets round the sides, and some of these inlets may be brought down through an upper storey; but as this plan tends to induce reversed currents, it is better, where possible, to bring the air by large tubes below the floor from the nearest convenient open area. In connection with these suggestions to lead air down or up as required, let me state most positively that the popular notions about the necessity of keeping a constant rise in all air shafts, etc., are utterly fallacious. Air can be led up or down, round corners, or through big or little holes, in fact, in any imaginable way, if only you arrange that there shall be a balance of tendencies in the required direction.

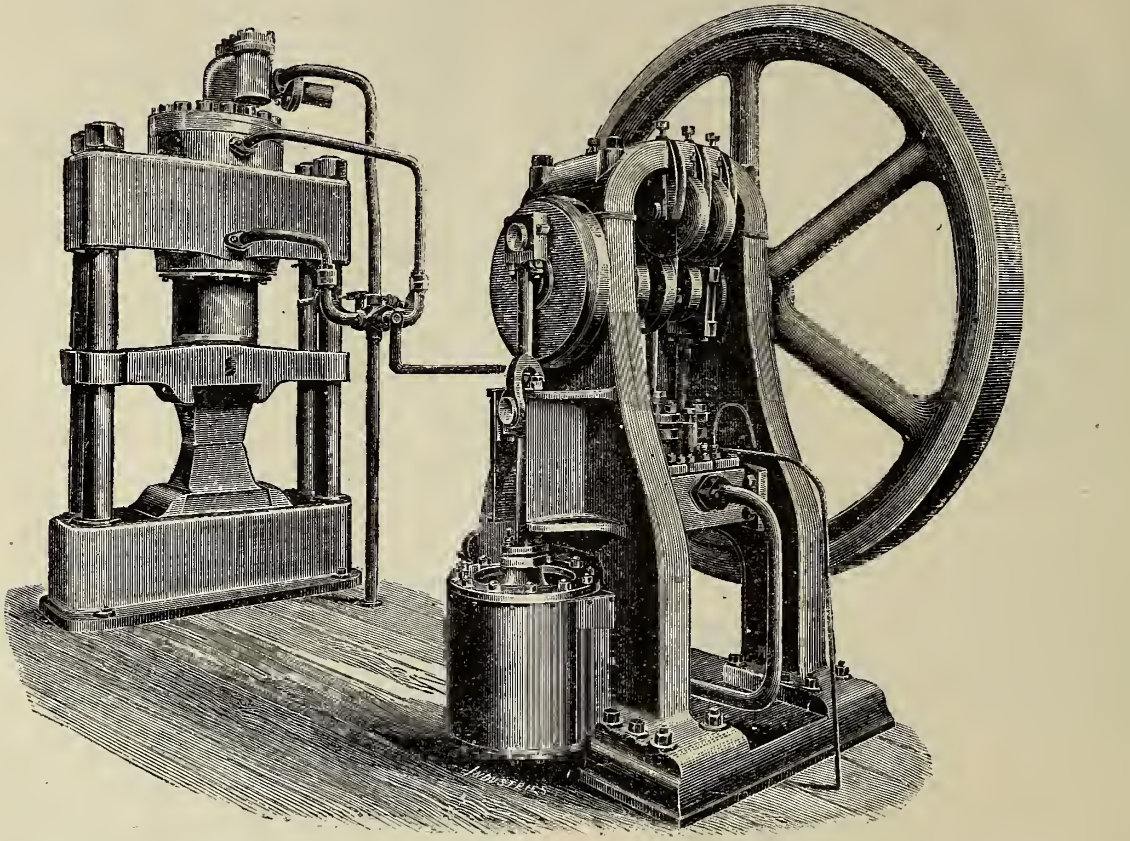
(To be continued.)

Admiralty Bungling Again.—It has just been discovered that the torpedo cruiser Porpoise, which is under orders to proceed to the China seas to replace the Wasp, is eight inches lower than she ought to be, and that when she leaves she will only be allowed to carry 250 tons of coal, instead of 400 tons, the quantity she was built to carry.

Proposed North River Bridge.—At a meeting of the American Society of Civil Engineers, on the 4th ult, Mr. Gustav Lindenthal described a proposed design for a suspension bridge over the Hudson River for the New York Terminal Railway, and having a central span of 2,850ft., and side spans of 1,500ft. The two piers at the ends of the central span would have a height of 400ft. If this bridge is ever constructed it will be by far the largest bridge in the world. The Forth Bridge has two central spans of 1,700ft., and two side spans of 675ft.

THE APPLICATION OF HYDRAULIC POWER.

HIGGINSON'S PATENT DIRECT SYSTEM.



Decidedly one of the most important recent inventions, brought to public notice by the Newcastle-on-Tyne Exhibition, was Higginson's patent direct system of applying hydraulic power. The makers of machinery worked by this system, Messrs. Harfield and Co., Blaydon Ironworks, Blaydon-on-Tyne, amongst their exhibits had several illustrative of the system, including three of Higginson's patent noiseless hydraulic winches, specially designed for use on passenger ships, as well as a 300 ton hydraulic hammer or squeezer, and the requisite engine and pumps for providing the hydraulic power. As might be anticipated, these exhibits received considerable attention from visitors, more especially from practical engineers, forgemen, &c., the hydraulic hammer or squeezer coming in for most attention, as being the first instance of this new mode of applying hydraulic power for forging steel and iron ingots. We have now the pleasure of illustrating and describing the 300 ton hydraulic hammer, engines, and pumps. Referring to the illustration—on the left is the hammer, consisting of a vertical cylinder 20¾in. diameter, fitted with gun metal glands and steel studs and nuts, and is capable of working up to a pressure of 2000lb. per square inch. The cylinder is mounted on four wrought steel columns, which are also utilised as the guides for the crosshead of the ram. The anvil forms part of the massive cast iron bed-plate which carries the columns. The ram is 19¼in. diameter, 15in. length of stroke, and is fitted with gun metal packing, ring, and studs. The cylinder is fitted with a valve box for controlling the water supplied from a tank, and an arrangement for valves and cylinders for automatically releasing the water when the maximum pressure has been reached. On the right of the illustration are the engines and the pumps. The former is a vertical engine, having a cylinder 16in. diameter, 12in. length of stroke, fitted with metallic packed piston, gun metal glands, neck bushes, drain cocks, and cased with sheet bronze. The crank and pump shaft are of steel, and carry a massive flywheel 9ft. diameter, weighing 2¼ tons. The pumps are three-throw, with gun metal rams 4in. diameter, 6in. length of stroke; and the valve box in connection is fitted with three gun metal suctions, and three delivery valves with seatings, and fitted with spring relief valve.

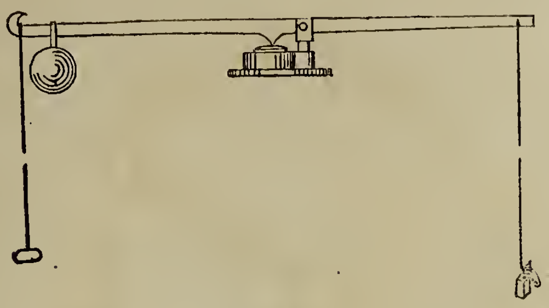
The modus operandi is somewhat as follows: The ram is brought down to its work by a head of water, and as soon as the die comes upon the ingot to be forged, the pressure of the pump comes into play, and the squeeze is completed by the momentum of the flywheel. It will thus be seen that without any costly accumulator a very powerful and at the same time a comparatively slow squeeze is obtained, more practical work being performed than by a great number of blows from a steam hammer. When what may be termed the pressure blow is complete, the hand lever is thrown out of gear by a self-acting valve, and the ram is raised; then the ingot is turned partially round for another pressure blow, and so on until the ingot is reduced to the forgeman's satisfaction.

By dispensing with the accumulator there is great economy in working, and a much cheaper and more efficient machine is produced, while with one engine and pump several hammers can be worked, and the steam consumed by the engine is proportionate to the work done. Although Higginson's hydraulic hammer does not apparently work as fast as hammers actuated by steam or gaseous power, yet the amount of work actually performed is much greater, as each pressure blow reduces the ingot much more than many blows of a steam hammer. The work performed is also more effective, as it has been found that in dealing with large masses of steel, a powerful squeeze is more efficacious in consolidating the material operated upon than a succession of blows, which, being comparatively light, have the effect of hardening and consolidating the external surface only, leaving the interior to a larger or smaller extent porous. It is no uncommon experience to find that large forgings manipulated under the steam hammer are not only porous, but have cavities in their interior, and these serious defects have frequently led to the condemnation of valuable iron and steel forgings, after a vast amount of time and work had been expended on them.

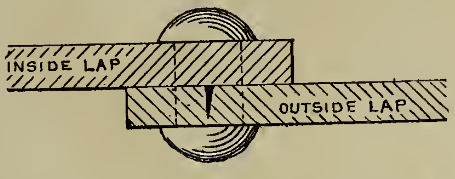
Among minor, but nevertheless important considerations, it may be pointed out that as this hydraulic hammer is self-contained, the foundations needed are light and inexpensive. There is also an absence of noise and vibration. As compared with the ordinary hydraulic system, it is also important to note that in Higginson's direct system there is a constant circulation of water through the whole machine, and back through the tank in connection with the pump. The hammer obtained the highest award and a silver medal.

THE DUDLEY BOILER EXPLOSION.—II.

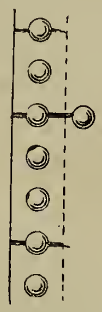
FORMAL INQUIRY.



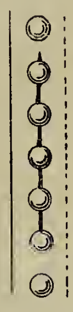
Sketch showing arrangement of safety valves with rods attached to ends of levers.



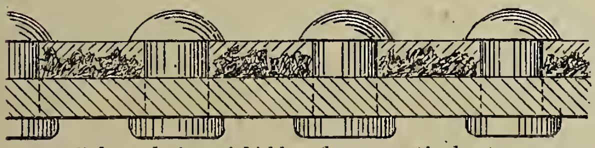
Enlarged section of vertical seam which failed showing position of hidden flaw.



Sketch of "edge-cracks," or "lap fractures," showing stop rivet.

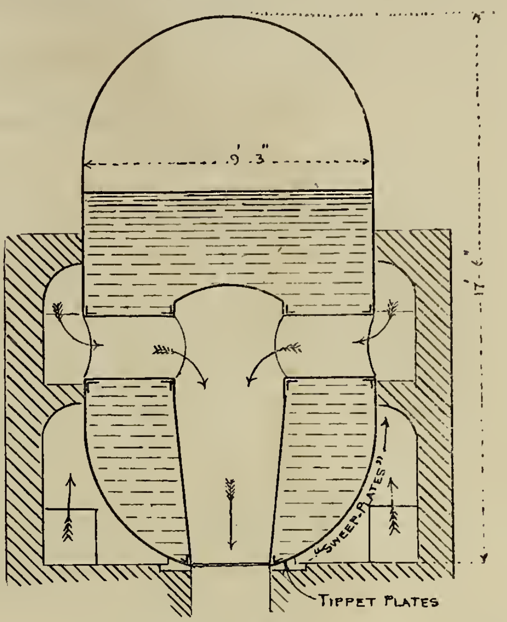


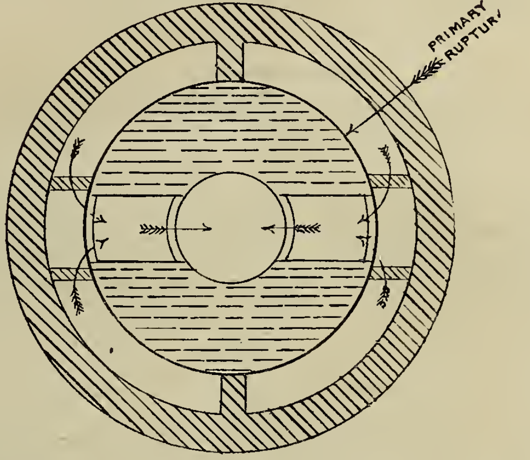
Sketch of a "seam rip."



Enlarged view of hidden flaw at vertical seam.

Vertical section of boiler, showing course of flues, etc.





Plan of boiler showing position of vertical seam which failed.

Continuing our report of this investigation, the next witness to be called was

Mr. Edward Bindon Martin, chief engineer to the Midland Boiler Inspection and Assurance Co., who said the boiler first came under the charge of his Company in 1863, and had been regularly examined by his inspectors ever since. The reports of the inspectors on the "thorough" examinations from 1871 down to the date of the explosion were here handed in and read.

Questioned by Mr. Smith as to why the rate for insurance was £36. 15s. per annum, while that for inspection was only £13. 13s., he said that when the rates for inspection were fixed in the first instance they were guided by the practice of the then existing associations and companies. They charged 13s. per boiler per annum in the first instance, but found from experience that the work could not be done for less than 17s., and although they charged a higher rate subsequently to fresh clients, they maintained the original rate to their old customers. The rates for insurance were based upon those charged by the other competing companies, and the system of group insurance required a higher premium, because the risk was greater. For instance, in a group of twenty-two boilers the risk of an explosion would be twenty-two times as great as if there was only a single boiler, and to cover this the premium required to be increased accordingly. When he inspected the boiler after the explosion he was surprised at the plate, which was $\frac{5}{16}$in. thick, giving way, and at first thought the steam pressure must have been abnormal, and that the stop valve was shut, and the safety valve in some way rendered inoperative. It was only because of the difficulty he experienced in proving that the working pressure had been exceeded that he was forced to conclude, what he never liked to do in accounting for an explosion, that there were some hidden flaws. These flaws were first pointed out to him by Mr. Watson. He believed they existed before the explosion, and considered that they began at the inside of the riveted joint, and did not come to the surface. Had he known of their existence he would not have insured the boiler. Referring to the hydraulic test, witness thought it was useful in good hands as an adjunct to inspection, but without inspection its application might be worse than useless; he did not think the hydraulic test would have discovered the seam-rips in this boiler unless it had been carried much beyond the ordinary working pressure. With regard to the pressure gauge, he did not think it necessary to have one fixed on each of the boilers at the works. Such fittings were only useful to the man who saw them, and when in the engine-house they were more under the eye of the attendant. Questioned with regard to the quality of the material, witness had no doubt the plates in the boiler were brittle, but the plates in old boilers were often found to become brittle, and he did not know that this applied more particularly to Rastrick boilers. In boilers of this type the heat was more locally applied, but the total amount was not very great. It was, after all, only waste heat, and such boilers as a rule did not make steam very fast. His Company had discovered seam-rips in other Rastrick boilers at these works, but he did not consider such defects were more common in this class of boiler than in others, although he thought edge-cracks were more frequent. Rastrick boilers of large diameter were, however, going out of fashion. When applied now, they were generally of smaller diameter, and fired with the gases from two furnaces instead of from four, which was usually the case some years ago. His Company had formerly 500 of these boilers on their books, but they now had only 260.

Thomas Talbot, engineman, said he was on duty at the time of explosion, and noticed the pressure gauge in the engine-house about a minute or so before it occurred. It then indicated 27lb. He never saw it up to 30lb. at any time on that particular evening.

Mr. Job Till Short, inspector to the Midland Assurance Company, gave evidence with regard to his examination of the boiler on the day before the explosion. The boiler, he said, was fairly well cleaned internally, and the dirt was also scraped out of the external flues, but the plates were not swept. He noticed a few slight leakages, and also one or two edge cracks in the sweep-plates, but he did not notice any of the old flaws at the part which gave way. He did not think the seam-rips could have been seen before the explosion. He had some portions of the plates that were blown out tested, and was of opinion that the iron was brittle. He was of opinion that the plates in the boiler were laid longitudinally instead of circumferentially, so that the rip where the plates first gave way ran along the grain instead of across it. He knew the boiler was about thirty years old. He did not think the hydraulic test would have discovered the defects in the boiler. He thought the explosion was due to excessive pressure, but he could not say what the bursting pressure was, nor could he explain how the excessive pressure occurred. The two furnaces in connection with the boiler had each an area of about 12 square feet, and 30 cwt. of coal was burnt in each puddling furnace in twelve hours, during which period there would be six heats.

(To be continued.)

MODERN MACHINE TOOLS.—III.

(Continued from page 41.)

The next group of machines was that of the milling tools, the most modern of all, so far as extended practical use was concerned. The great step in milling was the introduction of the emery wheel for the purpose of sharpening the cutters; and another step of smaller moment was the introduction of spiral cutters, tending towards increased finish of the work. One of the great advantages of using the circular cutter as against the single pointed tool was the increased cutting speed at which they could be used. In an ordinary sized cutter there was something like thirty to forty teeth, and as each cutting edge was therefore in operation but about one-tenth of a revolution, and cooling down the remainder of the revolution, they could therefore run a cutting edge for this short period at a considerably increased speed. The highest cutting speed for wrought iron, with a tool continuously employed, they knew to be 20ft. to 30ft. per minute, but when milling they employ a cutting speed of 60ft. to 80ft. per minute. In fact, taking the working of general engineers all round, he should think that the saving of time by using the milling cutter is from 20 to 50 per cent. Many persons considered these milling cutters very fragile, but it was curious to note that snipping and fracture did not occur with actual cutting, but with running the work against the cutters before the self-acting feed motion was put on. This suggested a remedy which he knew to be very effective, and that was never to allow the workman to run the work up against the cutter by hand, or until he could feel it, but to stop, say, a short distance from it, and set in the self-acting feed. There was no group of machines which so thoroughly tested their own sound construction as did the milling machines, for unless the greatest solidity, together with the highest accuracy of construction were employed, they were practically useless. When well constructed, they promised to become one of the most capable tools of the constructive engineer, for not only was the work produced in greater quantities, but it was also more perfect, and required little or no further finishing at the hands of the workman. This group of milling machines already form a numerous family, adapted for almost all the operations formerly performed by the slotting machine and shaping machine, and now the planing machine itself was being threatened by this rapidly advancing tool. In addition to the ordinary form of straight lines and circles, of which constructions are usually made up, this process of cutting metal lent itself very advantageously to the machining of irregular forms, or profiling, as it was called. Taking all things together, this group of machines he thought might without doubt be considered the machines of the future.

Turning next to the consideration of what might be termed special machine tools, Mr. Dixon observed that the greatly increasing competition in the several branches of engineering and allied industries have called for the highest skill in designing machines for the production of particular objects. They might take for an example locomotive building. Formerly it was the practice for these to be constructed in general engineering works where mill engines and general miscellaneous work was in progress, but to-day we had some of the very finest specimens of special machines employed in the production of the several parts of the locomotives; in fact, there was scarcely a single piece of the locomotive for which there was not to-day a machine, and sometimes several machines, specially designed for its rapid production, and though many of them have become obsolete by a change in the design of the locomotive, yet the first cost of one of these special machines was but a small item compared with the increased accuracy and rapidity of production. An illustration was afforded in the connecting rod. It was first planed by a special machine of short stroke, for doing both ends of two rods at the same time; it was then milled to form along the ends and edges; again by a special machine the cotter holes were drilled out both ends at once, and both sides of each end at the same time; again a special machine was constructed for boring both ends at the same time, besides other special machines for finishing the brass steps, cotters, etc., all for completing this small portion of a locomotive. He thought the finest specimen of machine work he ever beheld was a connecting rod, with its straps, steps, cotter holes, cotters, and everything complete, which had been finished perfectly by machines, and had never been touched with a file. He should say it was done by a foreign firm, but it was quite exceptional.

(To be continued.)

TALLOW.

Oil must be used for the lubrication of machinery, especially if the motion is rapid, but for heavy work it has not always sufficient staying power, and tallow or some heavy grease will do the work better. While tallow does not mix with water, it easily becomes saponified if in contact with any alkalies, such as potash, soda, or lime. It melts at 100° F., but boils and flashes at about the same temperature as the oils. Mutton tallow is by far the best; it is dry and white like lard, but becomes rancid and acid very quickly upon exposure to the air. For this reason it is unsuited for use in the cylinders of steam engines. It is frequently adulterated with plaster, which is easily detected by melting a sample, when the plaster will sink to the bottom. Besides this, tallow is not always cleaned, but contains earthy matter and pieces of bone and flesh, which more than counterbalance its lubricating powers.—*Power-Steam.*

A LEVELLING MACHINE.

A machine has just been introduced into some South Staffordshire works for imparting to sheets of iron, steel, or copper an absolutely flat surface. It is a patent levelling machine, the invention of Mr. J. W. Britton, of the Britton Iron and Steel Company, Cleveland, Ohio, weighing five tons. The machine comprises a bedplate composed of three girders running parallel, 14ft. long by 18in. deep, upon which is mounted a pair of powerful jaws, one at either end of the machine, for gripping the sheets as they are fed into it. The jaw at the head of the machine is connected by drawbars with the crosshead of a hydraulic ram, and the jaw at the opposite end is connected by suitable drawbars for changing the distance between the jaw, as may be required for the length of the sheets to be treated. In each jaw is a pair of automatic grips, which seize the sheet directly it is fed. Water having been let into the hydraulic ram, a severe strain is commenced, which is gradually increased until all the short places in the sheet are stretched equal to the long ones. This is the secret of the whole operation, and the material is left absolutely level, a feat which has never before been compassed. The hydraulic pump is fitted with two plungers of $\frac{3}{4}$in. diameter, which work against a piston in the ram of 7in. diameter. The normal working pressure required, as shown upon an indicator affixed to the machine, is about 3500lb. to 4000lb. per square inch, which will produce a strain of from 60 to 80 tons, and will flatten a pack of twelve sheets of about $\frac{3}{16}$in. thickness. The machine will bear a maximum pressure of 6500lb., which developes a strain of 100 tons. Work may be performed either with single sheets or in packs before bundling. The firms who have adopted the new principle in this country are Messrs. Hatton, Sons, and Co., best thin sheet and tinplate makers, Bilston; Messrs. Davies Brothers and Co., galvanisers, Wolverhampton; the Redcliffe Galvanising Company, Bristol; and the Blackwall Galvanising Company, London. —*The Engineer.*

SIR EDWARD WATKIN AND THE HEXTHORPE ACCIDENT.

Speaking at the half-yearly meeting of the Manchester, Sheffield and Lincolnshire Railway, Sir Edward Watkin, referring to the Hexthorpe accident, said: "It was a misfortune for the public, and for that noble class of men the engine drivers generally, that the Lord Chief Justice of England, and an English jury, should have exonerated the driver and fireman from the legal consequences which would follow to any man if he drove carelessly down Market-street, knocked somebody over, and killed him. If men got the idea that there were no penal consequences for such recklessness, it must make them not so careful as they otherwise might be. Then, with regard to the men themselves, it would make railway directors consider that if a driver committed the fault of running past the signal, or anything of that kind, to protect themselves, they must discharge him, instead of keeping him on in the hope that he would not commit a grave fault of that kind again. What was the real cause of that great fatality? Those present who had read the evidence before the coroners' juries would know that the driver said that he struck the Midland train, which was standing at the ticket platform, and then his engine rebounded and, to use his own words, "went into it again, and all the mischief is done." What was the result? The Midland train consisted of a weight, he believed, of carriages and passengers in carriages, of about 250 tons. The train was fitted up with one of those automatic brakes which the Board of Trade was always telling them was the only proper brake to use. He had always protested against automatic brakes, and the occurrence to which he was referring very much strengthened his reasons for doing so. The Manchester, Sheffield, and Lincolnshire train struck the rear of the Midland train, and it immediately put on the automatic brake right through the train, and the effect was that it converted a movable body into a thing like a brick wall—one solid mass of two hundred and fifty tons,—whereas if the brake had not been put on, and the Midland train had been pushed on for two or three hundred yards, very little mischief would have been done; but it struck a solid body, rebounded, and "went into it again," as the driver said, and the second blow on that solid body crushed up the two or three carriages in the rear of the train. He did not want to say any more about that; it was a very painful subject."

COPPER PIPES FORMED BY ELECTRICITY

The recent accident to the steam pipe of the s.s. *Elbe* lends a special interest to the electrolytic process for the manufacture of copper now being practised by Mr. W. Elmore, at Cockermouth. According to this method, such an article as a steam pipe can be produced without weld or joint, and having a tensile strength from 50 to 100 per cent. in excess of first-class brazed pipes. Further, this result can be attained with the use of a very inferior quality of copper, and at a cost which will enable the electrolytically made article to compete in the market with the customary varieties. Of course there is nothing new in depositing copper in a tubular form, but hitherto such metal has been too brittle to render it reliable for use in circumstances under which it is exposed to great stress. For copying engraved plates, and for the rollers of calico-printing machines, deposited copper has been used with great success, and when it has been thrown down very slowly it has been possible to produce very satisfactory qualities of metal for these purposes. The novelty introduced by Mr. Elmore, however, lies in breaking down the crystals almost immediately they are formed, and pressing them out into a fibrous form, in which they are interlaced and matted together. To this end the iron core or mandrel on which the metal is deposited is kept constantly rotating in the bath, and an agate burnisher is slowly moved backward and forward lengthwise of the cylinder, as if to cut a screw thread upon it. The speeds are so arranged that a layer of copper seven-thousandths of an inch thick is deposited between each reciprocation of the burnisher. When the required thickness has been attained, the mandrel is lifted out of the bath and placed in a vessel supplied with superheated steam. In a few moments the expansion of the copper detaches it from the iron, and the shell can be stripped off. Pieces cut from such tubes have been submitted to breaking tests by Messrs. Kirkaldy and Co., Professor Kennedy, and Professor Unwin, and have broken at strains varying from 27 tons to 41 tons per square inch, and with an extension varying from 5 per cent. to 7½ per cent. in a length of 10in. The metal can be worked under the hammer most easily, and can be drawn, bent, or compressed without annealing, and without any tendency to crack. Specimens polished and submitted to the microscope show that the electrolytic metal has a perfectly compact and homogeneous structure, while drawn copper is a honeycombed mass of crystals, only connected together at points. The success which has attended the experimental stage of Mr. Elmore's process encourages the belief that absolute security from burst copper steam pipes can be secured in the future, and that we are on the eve of being supplied with a greatly improved quality of copper for all purposes.—*Engineering.*

CORRESPONDENCE.

We do not hold ourselves responsible for the opinions of our Correspondents.

PLATE FLANGEING.

To the Editor of "The Practical Engineer."

SIR,—Your correspondent "Hemisphere" is quite mistaken if he thinks I am unacquainted with the difficulty of flangeing either into a hemispherical shape or a right-angle flange, as I have seen both done; and if he would take the trouble of looking again at the kier end he will find it neither the one nor the other, but a "camber," 18in. from bottom to top, flange included, and is only part of a sphere of 9ft. diameter, the diameter of kier being only 6ft. 6in.; and I say again that it is only a simple hydraulic operation, which can be done by any firm having a hydraulic flangeing press. In the case of the vertical boiler end, it is a double flange done with one heat, and in a single operation, from a flat plate having a 4½in. hole in centre.—I remain, yours truly, A. S.

Glasgow, 30th January, 1888.

To the Editor of "The Practical Engineer."

SIR,—In reading the very interesting discussion which has been going on in your valuable paper, I see an argument between "Hemisphere" and "A.S." as to relative merits of the two kinds of workmanship, one a kier end plate, the other a crown plate for a vertical boiler, both flanged in one operation. My object, Sir, is to explain the two modes of flangeing, and leave your readers to judge which is the greatest feat of the two. The kier end is simply a round plate $\frac{9}{16}$in. thick. A cast-iron block and a ring with clearance allowed are requisite for the work of flangeing. The block and plate are simply forced through the ring, and there ends the great feat that "Hemisphere" is boasting so much about. In A. S.'s sketch quite a different mode of procedure is adopted; two blocks, one pressing the plate inside, the other something like stamping under a steam hammer or hydraulic forging press, are used. But previous to this I find there will not only be the size of the plate to determine on the outer edge, but the size of the hole also, and if "Hemisphere" would just try that, if he has the opportunity, he would find there is more complication in this than he would otherwise imagine, and his respect for the vertical boiler crown plate would increase accordingly. Apologising for trespassing on your valuable space.—I beg to remain, yours truly,

Glasgow, Jan. 30th, 1888. PRACTICUS.

AN ENGINEER'S LIFE AT SEA.

To the Editor of "The Practical Engineer."

SIR,—Among seagoing engineers the saying is emphatically true, "Many men, many minds." There is also much difference between a mail steamer carrying four or more engineers, and a merchant steamer carrying only three. For the latter four hours should be made an irreducible minimum for raising steam; some engineers would say six. When time permits, and where engineers are resident on board, both of which conditions are rarely fulfilled at the same time in the steamers we are considering, then this time may be exceeded at pleasure, but it will be very rarely that the boilers can be run up several days before starting. The rest of your correspondent's letter is based upon misreading, and another perusal will show that the absurdities he imputes are not mine. In the case of all of us it is best to credit others from whom we differ with the greatest intelligence and experience that we honestly can.—Yours, etc.,

THE WRITER OF THE ARTICLE.

ENDLESS RAILWAYS.

To the Editor of "The Practical Engineer."

SIR,—In the *Manchester Evening Mail* of January 24th, 1888, the following paragraph appeared: "Lieutenant Tipping, superintendent of the Irish Lifeboat Stations, has just introduced a contrivance which promises to be of great advantage in facilitating the conveyance of lifeboats from the boathouse to the launching point. The object in view is to provide the boat carriages with revolving sand-plates, which are three feet long and have flat surfaces. These prevent the sinking of the wheels into the beach or sand, which has hitherto been such a great obstacle to the transport of lifeboats. By means of this invention, at recent experiments, a boat was taken from the boathouse to the fall in one minute five seconds, whereas it took 30 minutes to take her the same distance without the aid of the sand-plates." This seems remarkably like Fender's Patent Endless Railway, described in *The Practical Engineer*. December 30th, 1887, and I should like to know if it is a case of plagiarism, or are there two inventors of the same contrivance? Perhaps, if you called attention to the above in your paper, it might be the means of bringing the endless railway patent before the National Lifeboat Institution. The application of this to such lifeboat carriages as at Southport, where there is a great expanse of sand, would be of great value.—Yours truly,

RESCUE.

25th January, 1888.

THE BROCKMOOR BOILER EXPLOSION.

To the Editor of "The Practical Engineer."

SIR,—The first formal investigation under the "Boiler Explosions Act" has recently taken place, viz., on the 18th and 19th inst., in connection with the explosion at the Brockmoor Iron Works, near Dudley. When the inqnest on this disaster was held, the theory that the explosion arose from a hidden fracture was started, I believe, by the parties who were responsible for due attention to the valves attached to the boiler, and an assertion was made to the effect that the stop valve must have been closed, after it had been opened by the man responsible for doing this. The facts are that this stop valve was practically closed at the time of explosion. The safety valve was of rough construction, and the facings in very bad condition, being in such state that there would be probability of the valve having to be overloaded to prevent the steam escaping in large quantity, whilst a valve in such condition might easily stick fast and become inoperative. I am convinced that although the boiler was considerably worn, and the margin of strength much reduced, and although the fracture at the seam which first failed may have existed previously as alleged, the actual cause of the explosion was over-pressure, due to the stop valve being closed, and the safety valve not discharging the steam as rapidly as it was formed; thus accumulation would occur until the boiler failed at the weakest point. Such explosions have occurred previously, as witness the disaster on board H.M.S. "Thunderer," which arose through the safety valves being fitted too tightly, and through the stop valve being closed. A similar explosion of one in a set of eight "Lancashire" boilers occurred several years ago, at a paper mill in Lancashire, where the old safety valve had been removed and substituted by a new one. In this case, the explosion occurred, like that at Brockmoor, when the boiler was being re-started after stoppage. After the explosion, the stop valve was found by the experts who investigated the matter to be wide open; but suspicion being aroused respecting this valve, the men in charge of the boilers were specially and separately examined respecting it, but all asserted that it had not been touched after the explosion. The new safety valve was found tight in its seating, but as the stop valve was alleged to be open, a verdict was returned at the inquest which was held ascribing the explosion to deficiency of water. Subsequently, the above suspicion was confirmed, it being ascertained that the stop valve was actually closed when the disaster occurred.

Whatever opinion may be formed respecting the suitability or otherwise of Rastrick boilers for iron works, there is no doubt they are a favourite boiler with many parties having control of works of this kind, and new ones continue to be made accordingly. It can also be shewn by statistics that where they are carefully attended, and exposed to fair and reasonable treatment, explosion from any cause is rare. Unfortunately the working and management of these boilers is, in some cases, the very opposite of what is generally considered necessary to safety. They are without doubt more liable to dangerous fractures and other defects, and are certainly much less safe than well-constructed boilers in which the heat first acts in an internal tube or chamber. Occasional removal of brickwork is certainly most important, where this is of great breadth, or if it hides riveted seams; but the brickwork of all classes of boilers can be so arranged that its removal will be very seldom necessary; and even where, as with the Rastrick boilers, the brick shields have to be removed, this can be done with suitable setting, without disturbing the permanent supports, &c., of the boiler. The adoption of safety valves of the "Cowburn"* dead-weight type, which is the most reliable form of safety valve ever made, would much reduce the facility of overloading. I believe that no valve of this construction in constant use on a boiler has ever been found actually inoperative —hence the great value of this type of fitting as a safeguard against over pressure. I do not intend to enter into any discussion of the matter, my only object in writing being to direct attention to what I believe is the actual cause of the disaster referred to, and prevent the public and others being misled, or advised to do certain things which a mistaken conclusion in reference to this event may lead those who have to report upon it to recommend, as the evidence above indicated caused the jury to do at the inquest.—Yours, &c.,

EXPERIENCE.

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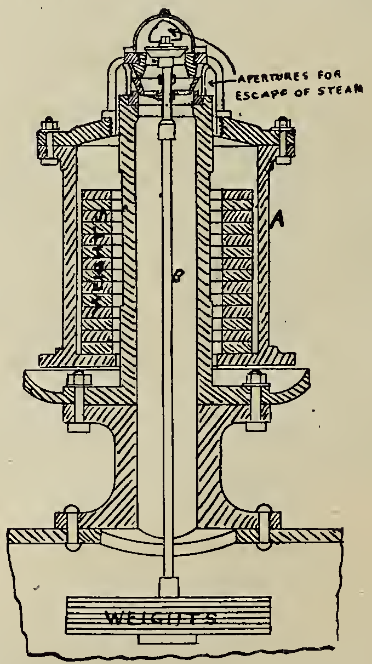
* The patent of this valve lapsed long ago, and the inventor is dead.

QUERIES AND REPLIES.

HOPKINSON'S SAFETY VALVE.—Could any reader give me a description of Hopkinson's dead weight safety valve, and show how to calculate the weight for different pressures. A sketch will oblige.—S.S.N.

Answer.—This valve, or more properly, combination of valves, consists of three valves placed vertically over each other, as shewn in sketch herewith. The action can be readily inferred by reference to the drawing



The lower valves are loaded by means of weights contained in the box A, and the upper or small valve is loaded internally by weights suspended in the boiler by a rod B. The rule for the inside valve must be

$$\text{Area of valve} \times \text{pressure} = \text{load}.$$

$$\therefore \text{pressure} = \frac{\text{load}}{\text{area of valve}}$$

But in what ratio the outside valves are to the inside I am unable to say Perhaps you will be able to draw an inference foom the patentee's words:—"Valves for 80lb. pressure have a circumferential opening, to discharge steam, of 27in, and the weight required is 320lb., on the inside valve, and 320lb. on the outside valve, or a total weight of 640lb. dead weight.—J.R.

ENGINES OF THE ETRURIA.—Could any reader supply me with the leading dimensions of the engines of the *Etruria*, or *Ormuz*.

Answer.—In my answer to this query last week, the propellor is wrongly given as 246in. diameter, this should be 24ft. 6in. I might add that the greatest and least diameters of the shaft are 27in. and 24in.—F. GROVER.

ENGINE-ROOM ARTIFICER.—What is the pay, amount of service, age and size, and length of apprenticeship, required of an engine-room artificer? Could I join at any time?—G.H.A.

Answer.—If "G.H.A," will forward his name and address to me, I will send him a printed circular containing the full particulars that he requires. —R. L. FRYER, 32, Autumn-st., Burley Lodge-rd.. Leeds.

Marine Problems.—(1) Suppose a marine engine to be developing the full horse power, will it, when the steamer is making its way up a river, give the same number of revolutions as when the steamer is going down the river, neglecting the friction of the air due to the varying speeds of the vessel in the two cases? (2) A steam ferry boat requires to cross a river in a straight line, but owing to the current the steamer has to be headed partly up stream all the way across, and thus it crosses in a straight line, but in a sideway position. Will the pressure of the current on the vessel be greater or less on the upside than on the down side?—R J.G.

Answers.—(1) The latter portion of "J.R.'s" reply to this query last week was incorrect. The pressure on each side of the ship would be exactly the same: were it otherwise, then some apparatus could easily be designed, which would shew the inequality of pressure, so that on a dark night a reference to this gauge would at once shew which way the current was running, if unknown previously to the observer. Or again, when dangerous currents were carrying a ship on to rocks invisible in a fog, such an indicator would at once show the direction in which the ship was drifting. That no apparatus can be devised which will show the direction of drift in the open sea or during a fog, appears to prove that there is no inequality in the pressures on each side of a vessel afloat in the swiftest current. I was interested in noting the query and correct answers given to the question of speed of revolution, for I have found among sea-going engineers an almost unanimously incorrect view taken of problems similar to this. In fact, among average marine engineers such a view, if propounded and persisted in, is like throwing a red rag to a bull. Let any one who doubts this try it, —.C.

(2) That part of "J.R.'s" answer to "R.J.G.'s" enquiry in last week's paper, as to whether there is a greater pressure on the up or down stream side of the steam-boat under the conditions there supposed, which conditions being that the boat is free to move in and with the current, is altogether in error; in reality there is no appreciable difference in the two pressures, whether the engines be moving or at rest. If we suppose the boat anchored or moored with a broad-side to the stream, or at any other angle therewith, then the current will exert its force on the up stream side of the boat, increasing the pressure on that side by that amount, which will be equal to the tension or strain on the mooring chains; if we now suppose the mooring chains to be cast off and no longer to restrain the vessel, it will in consequence of the excess of pressure commence drifting with the current. with increasing velocity and diminishing difference of pressures, until it has attained the same velocity as the current itself, when the pressure on both sides of the boat will be equal, and any effect produced by the engines will be the same on one side of the boat as on the other; so that practically the pressures are on each side equal, whether the engines be moving or not.—W.A.

Chrome Iron.—I should be obliged for the name of any firm who manufacture chrome iron. I want a quantity of castings containing 15 per cent. of chromium.—Anxious to Trade.

Wöhler's Experiments.—I should like a formula which will represent the results of Wöhler's experiments on the repetitions of loads. Compare the diameters of the shafts of two engines, the power transmitted, and revolutions of each being the same; in one the twisting moment fluctuates between 1¼ and ¾ the mean, and on the other between twice and ⅓ the mean.—H.T.

Strength of Lap Joints.—In a single-riveted lap joint exposed to tension, determine the diameter and pitch of the rivets in terms of the thickness of plate, and the three stresses f_t, f_s and f_b,

Where f_t = intensity of stress on material of plate.

" f_s = " " " rivet.

" f_b = " bearing pressure,

estimated on a diametral section of rivet. Find the diameter and pitch for ½in plates when $f_t = 30$, $f_s = 22$, and $f_b = 42$ tons per square inch, and estimate the efficiency of the joint.—H.T.

Marine Engines.—Why does the centre line of engines not always coincide with fore and aft centre-line of vessel, as in the case of the *Ormuz*. I presume that it is not the screw shaft that is out of line, but that the engines are inclined a little from the vertical?—Shiny Boots.

Locomotive Tank Engines.—What are the tanks of these engines cleaned with, and, why do they prime so furiously on the day after such cleaning?—Shiny Boots.

Load on Safety Valve.—Will "T.W.," Blackburn, or some other correspondent please say to what pressure the escape valve on pump and safety valve on economiser should be loaded for a pressure in boiler of 100lb.?—T.H.

Steel Castings.—Would any of your readers give me any information as to the theory of moulding and casting the above? Also if there is any work published on the subject?—Moulder.

TO CORRESPONDENTS.

H. Rule.—Our charge for this class of advertisement is 12 words for 6d., and ½d. per additional word. Replies received at this office will be forwarded to the right destination.

Epsilon.—The calculation for the radius is made by the help of the calculus, and the result is $r_{,} = 1·1586\ r$, or what comes to the same thing, the angle between the extreme radii of the dividing circle is 109° 12′. We are contemplating taking up other subjects, but our arrangements are not complete.

A.R.—It all depends on the pitch of the leading screw. Suppose this is three threads to the inch, then the wheels might be 15. 50, 20. 50 If the leading screw has four threads to the inch, the wheels might be 20, 50, 20, 50.

J.D.—See answer to "Myra's" question in last week's issue. If your engine is a compound one, of modern construction, we should expect that one boiler 28ft. by 7ft. 6in., would be ample for the work; on the other hand, if the engine is inefficient very hard firing might be necessary with one boiler, while with some engines two boilers would be required.

Piston Rod.—As a rule, in first-class practice the conical end of piston rod is always swelled. Split glands are adopted when rod and cross-head are in one, as in marine engines. Owing to the large margin of strength allowed in designing piston rods, some makers taper the piston end of rod down without any swelling, to save labour and expense. This, so far as we are aware. is only done in inferior work. The cross-head and connecting rod end bolts, in addition to being in tension, are also subject to a transverse strain, as their axes are placed some distance from the point of application of the force, viz., centre of bearing. The larger margin of safety allowed for this accounts for their combined sectional area being sometimes larger than that of piston rod.

Subscriber.—Let D = diameter of boiler in ft., t = thickness of shell in ins., and P = bursting pressure in lbs. per sq. in. Then $P = \frac{7920\,t.}{D}$ Again, let d = diameter of flue in inches, length of flue in feet = l, and t = thickness of flue plates in inches, while P = the collapsing pressure of the flue in lbs, per square inch. Then $P = \frac{437530t^2}{dl}$. Subscriber does not say in what manner he intends to test his boiler; but if by water pressure he must examine whether there be any leakage, and by straight-edge or other means applied to the ends of the boiler see whether, and how much, they bulge under the pressure, and whether they return to their normal state on the removal of the pressure; by one or more wires drawn tightly round the boiler and marked when no pressure is on the boiler see whether the shell expands under pressure and whether it returns to its normal girth on the pressure being removed; by gauges across the flues take the diameter in different directions before. during, and after the application of the pressure, and note the result of the changes, and whether the flue returns to its normal state. As to the enquiry of what difference of expense in working a compound engine or a single condensing one, You give no data as to dimensions, pressure, piston speed, or rate of expansion. We will, however. deal with it in the best way we can, and suppose the two engines to have each the same initial steam pressure P-lbs. per square inch on the piston, and the same back pressure p lbs. per square inch opposing the pistons on the condenser side. Let a = area of high pressure cylinder, A = area of low pressure cylinder, A = also area of cylinder of single engine, L = length of stroke of each piston, l = length to point of cut-off in high pressure cylinder, n = the number of strokes of engines per minute both being the same. Then foot-pounds per stroke of compound engine =

$$P a l \left(1 + \log. \frac{L}{l} + \log. \frac{A}{a}\right) - p A L,$$

and foot-pounds per stroke of single engine = $PAL - pAL$; volume of steam consumed each stroke by compound engine = $a l$; volume of steam consumed each stroke by single engine = AL;

$$\text{compound engine: } \frac{\text{work done}}{\text{steam used}} = \frac{P a l \left(1 + \log. \frac{L}{l} + \log. \frac{A}{a}\right) - p A L}{al}$$

$$= P\left\{1 \div \log. \left(\frac{AL}{a l}\right)\right\} - \frac{pAL}{a l} \;(1);$$

single engine: $\frac{\text{work done}}{\text{steam used}} =$

$$\frac{PAL - pAL}{AL} = P - p \;(2.)$$

Where equation (1) is palpably greater than equation (2) there is more work done for the steam used in the first case than in the second. The above logarithims are Naperian. By substituting numbers for the above letters and working out the result the advantage of any particular or desired arrangement of compound over single non-compound engine may be seen, as shown by the ratio of (1) to (2), which shows the gain in power when equal quantities of steam are used by each engine. As to wear and delapidation of the cylinder and piston we have known them to work for ten or twelve years without repairs, but of course all this depends on the care taken and the quality of the metal in wear.—W. A.

MISCELLANEA.

The Strong Locomotive.—The corrugated fireboxes of the Strong locomotive have, according to the *Railroad Gazette*, had to be removed after only a few months' service. The failure is not attributed to any fault in the flue itself, but to the joints being of faulty design and improperly made by the workmen. It is expected that more satisfactory results will be attained when the workmen have had more experience.

Tests of Oil.—The only reliable test of oil of which I have heard, says a writer in *Power-Steam*, is the actual use upon the cylinder to be lubricated; and in making such a test at least fifty gallons should be used, for in many instances an oil that works well for the first five or ten gallons will commence to show its bad qualities when used for a longer period, and on the other hand often the good quality of oil will fail to work to the best advantage until a considerable quantity has been used.

Belt Grease.—A belt grease highly recommended by the German Car Builder is made as follows: Melt three parts common soap with one part palm oil, and add to the mixture four parts ammonia soap (which is obtained by saturating oil soap with carbonate of ammonia) and 1⅔ parts of a tannin solution obtained by dissolving sixteen parts tannic acid in four parts water. The whole is thoroughly mixed, and can be kept for a long time in closed stone jars. When this mixture is applied to the leather, care should be taken not to use too much of it, but just sufficient to saturate the leather.

PETROLEUM.—The Indian Government has decided to levy an import duty on petroleum.

MANGANESE ORE.—It is stated that a solid vein of manganese ore, 25ft. thick, has been discovered near Cartersville, Georgia, U.S.A.

A LONG OIL PIPE.—A new oil pipe line is in contemplation between Chicago and New York. The length will be about 1000 miles, and the cost £1,000,000.

STEEL RAILS.—The leading American railways placed orders for 90,000 tons of steel rails with the owners of various American mills last week, at $31½ per ton. It is estimated that 1,500,000 tons of American steel rails will be ordered this year.

MUNIFICIENT DONATION.—Mr. Samson Fox, C.E., the founder of the Leeds Forge, has given a donation of £30,000 to the Royal College of Music. The sum will be expended upon the building of a permanent College on a piece of land at Kensington Gore to be granted by the Commissioners of the 1851 Exhibition, and in close proximity to the Imperial Institute.

ENGINEERING SOCIETY, KING'S COLLEGE, LONDON.—The following are the concluding papers for the Lent term, 1888: Feb. 7, Mr. Metzgar, Liquid Fuel; Feb. 14, Mr. Walmisley, The Roof of Olympia; Feb. 21, Mr. Jones, Cable Tramways; Feb. 28, Mr. Schwartz, Water and Water Supply; Mar. 6, Mr. Frere, Bridge Foundations; Mar. 13, Terminal, Business Meeting.

TRANSMISSION OF POWER.—The transmission of power in American mills is effected almost universally by means of belting. Several Canadian mills, however, are driven by means of ropes. One reason of the continued use of belting has undoubtedly been the abundant supply of leather, and the successful methods early employed for the manufacture of belting which is uniform both in thickness and in elasticity.

DREDGER FOR THE SHIP CANAL.—Mr. T. A. Walker, contractor for the construction of the Manchester Ship Canal, has placed an order with Messrs. Fleming and Ferguson, shipbuilders, Paisley, for a large and powerful dredger. The vessel will be propelled by twin screws, and is to be capable of raising 600 tons per hour from a depth of 35ft. Her machinery throughout is to be of the most improved kind, and she is to be fitted with patent quadruple expansion engines to indicate 700-horse power.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.—The next meeting of this institution will be held at Newcastle-upon-Tyne, on Wednesday, February 8th, at 7-45 p.m. Business—1. Discussion on the paper on "The Combustion of Coal, and some Evaporative Experiments with Natural and Forced Draughts," by Mr. W. G. Spence. 2. Paper on "The Results of some Experiments made on Rowe's Double-strapped Butt-joints," by Mr. James Patterson.

INSTITUTE OF ENGINEERS AND NAVAL ARCHITECTS.—On Monday, the 23rd ult., the Hull and District Institute of Engineers and Naval Architects held their fifth general meeting of the session 1887-8, at the Mechanics' Institute. An interesting paper was read by Mr. J. H. Laidman on "Improved Construction of Stern and Rudder Frames." The lecturer claims for his invention saving in cost of manufacture, reduction in weight, greater facility in effecting repairs, &c. The next meeting of the institution will be held on Monday next, when a paper will be read by Mr. J. R. Smith, on an enquiry into the most efficient method of further utilising heat in the marine steam engine.

UNIVERSITY COLLEGE BRISTOL—ENGINEERING SOCIETY.—At a meeting of this society held Wednesday, Jan 25th, the officers for the term were elected as follows:—President, Prof. Ryan, M.A., D.Sc., M.I.M E; Hon. Vice-President, D. C. Selman, Assoc. M. Ins. C.E.; Vice-President, John P. Littleton; Secretary and Treasurer, A. J. Ward; Librarian, C. P. Banham; Committee, Messrs. Dix, Fenseca, Pinto, Ames, Shepherd, and Bruce. A few remarks were made by the secretary upon the satisfactory nature of last terms proceedings. He alluded to the successful excursions, interesting papers, and animated discussions at the close of each, and promised a renewal of the same during the present term.

TRIPLE EXPANSION ENGINES.—An interesting example of the value of triple expansion engines as compared with compound was exhibited on the Clyde, on Saturday, on the trial of the Orient liner Cuzco, which has recently been thoroughly renovated by the Fairfield Shipbuilding and Engineering Company, and furnished with new boilers working at a pressure of 150lb. to the inch, and with triple expansion engines of the most approved type. The Cuzco is 17 years old, and has hitherto been regarded as a 12½-knot boat. On Saturday she was tried on the measured mile for a six hours' run, when she attained a speed of 16 knots. This increase in speed was accompanied with economy in coal consumption, and the incident is remarkable on account of the success with which the power of the new engines has developed a high speed in a vessel the model of which is comparatively obsolete.

THE LATE MR. JOHN WADDELL.—The death is announced, in the sixtieth year of his age, of Mr. John Waddell, the well-known engineer and railroad contractor. The deceased gentleman was a native of Lanarkshire, and has been engaged in railroad construction for practically the whole of his life. Amongst the many works carried out by him may be mentioned the construction of the Caledonian main line short route between Edinburgh and Glasgow, and the formation of the Tay Bridge Railway connections. He constructed several of the Great Eastern lines in Norfolk, and erected the Putney Bridge over the Thames, which was opened by the Prince of Wales. His most signal triumph in engineering, however, was the tunnelling beneath the Mersey to allow of railway communication being established between Liverpool and Birkenhead.

SELECTED PATENTS.

APPLICATIONS FOR LETTERS PATENTS.

January 20th.

877 ADJUSTING CARDING ENGINE CYLINDERS, G. Ashworth and E. Ashworth, Manchester.
878 CUTTING AND PUNCHING, S. Matthews, Newcastle on-Tyne.
879 GAS AND OIL BURNERS, W. H. Blakeney, Dundee.
881 SAFETY APPARATUS FOR GAS ENGINES. P. P. Ayres, Birmingham.
884 WEIGHING MACHINES, G. P. Skipworth, Bath.
885 INGOT CRANE, J. Otter, Sheffield.
889 STOVES, A. E. Fletcher, Liverpool.
89) IMPROVING CHIMNEY DRAUGHTS. E. P. Brett, York.
899 RAILWAY CHAIRS, F. S. Morris, Adelphi.
908 PUNCHING JACQUARD CARDS, P. A. Comte de Sparre.
909 GAS MOTOR ENGINE, J. Southall, London.
912 BOILER PLATES. D, Purves A. Ll. Jones and W. J. Darling. Middlesex,
913 CUTTING MACHINE BELTING, G. B. Malli son and W. Speight.
916 SLIDE VALVES, T. Lockerbie, London.
923 FOG SIGNALLING APPARATUS, C. Tighe. Middlesex.
926 FREEZING MACHINES, W. H. Tomson, Middlesex,

January 21st.

927 JAW FOR PIPE AND BOLT WRENCHES, H. W. Atwater, London.
928 BUFFERS, A. Spencer, London.
933 ELECTRIC CLOCKS, P. Bosshardt, London. (L. Bouchet, France).
943 BLOWERS, J. T. H. Asbury, Birmingham.
947 GOVERNING MECHANISM, S. Buckley and J. Taylor. London.
953 GAS BURNERS, G. J. O'Reilly, London,
954 SCREWDRIVERS, D. R. Hart, London.
958 RAILWAY CHAIRS, R. Armstrong, Glasgow.
964 ARGAND GAS BURNERS, A. M. Craig, Middlesex.
972 TRUSSED GIRDERS, J. Goüin, London,
973 INTERNAL FLUED STEAM BOILER, C. J. Galloway and J. H Beckwith. London

January 23rd.

998 MECHANICAL STOKERS, A. Thomson. Glasgow.
1009 DYNAMO-ELECTRIC MACHINE, J. H, Davies: Paddington.
1010 DIFFERENTIAL SCREWS. C. Junge, and W. Junge. London.
1013 PROJECTILES, C. A. MEvoy. Southwark.
1015 PUMPING ENGINES, E. Barnes and Tangys, (Limited).
1021 AUTOMATIC LOCK FOR SCREWS, &c, A. Davies, London,
1028 CABLE GRIPS, W. J, E. Carr and J. E. Carr, London.

January 24th.

1035 COMBINED SPEED AND PRESSURE INDICATOR, T. Thorp, Whitefield.
1038 BOILER FURNACES, J. Rankine. and J. P. Hall, Durham.
1054 PREVENTING THE COLLAPSING OF FURNACES, J, Rankine. N. Shields.
1059 TAPS, VALVES, &c.. C East and C. W. East, Middlesex.
1061 VALVES. W. P. Thompson, Liverpool. (The Barnett Brass Co., U. States
1061 JOINTS OF RAILS FOR FIELD RAILWAYS, A. Dolberg, Berlin.
1071 CLUTCH, A. S. Rowley, London.
1072 CIRCULAR SAW BENCHES, E. Cory, F. W. Reynolds, and G. W. C. Catford, London.
1081 CRUSHING MACHINES, A. P. Granger, London.
1087 STEAM BOILERS OR GENERATORS, S. Orlando, London.
1100 ELECTRICAL BRAZING AND SOLDERING, G, Downing, Middlesex.
1101 ANTI-CORROSIVE COMPOSITION, J. O. Wallace and W. Ward, London.
1103 COMMUNICATING SIGNALS ON TRAINS, P, Daley. London.
1106 GRINDING MACHINERY, R. Stone London,
1107 ROLLER MILLS, P. Tafel, London.

January 25th.

1116 WEIGHING MACHINES, C. E. Payne, Birmingham.
1118 PACKING FOR STUFFING BOX, J, J, Galloway, Glasgow.
1135 METALLIC CEMENT, A. Clery. London.
1136 BELT FASTENER, T. C. Sargeant, Northampton.
1137 DRIVING-GEAR FOR TWIN SCREW PROPELLERS, E. Hunt. Glasgow. (E. Henry, France.)
1141 ROD CLIP, E. Neale and F. Carter, Birmingham.
1147 DRILLING MACHINES, A. Whitney, London.
1156 SIGHT FEED LUBRICATOR, W. Grimes and C. C. Wakefield, Liverpool.
1160 LOW PRESSURE BOILERS, H. Davey, Westminster.
1165 RATCHET DRILLS, A. Schütz, E. Schultes and R. Plücker. London.
1168 SUPERHEATER FOR STEAM, T. Bell, London. (J. Niven, Uitenhage.)

January 26th.

1180 RACK AND CATCH, A. P. Jevon. Birmingham.
1185 ROTARY ENGINES, J. Monteith, Glasgow.
1200 FUSIBLE PLUG FOR BOILERS, H. Field, Middlesex.
1202 RAILWAY SLEEPERS. W. G. Bognall, and A. H. Heath. Middlesex.
1203 SAFETY LAMP, T. Jackson, Chiswick.
1208 ACTUATING RAILWAY SWITCHES, A. J. Martinsand A. Coelho da Rocha, London.
1214 GAUGE GLASSES, J. Werner, London.
1234 CIRCULAR RAILWAYS, A. H, Crockford. London.

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EDITORIAL NOTICES.

All communications for the Editor of this Journal should be addressed to the Manchester Office, 3, Grosvenor Chambers, Deansgate, Manchester.

Communications intended for insertion in the current week's issue should reach us not later than Tuesday Evening.

We cannot undertake to return rejected manuscripts or drawings unless accompanied by a stamped and directed envelope.

Contributors are requested to write on one side only of the paper. Sketches should be sent on separate sheets.

TO ADVERTISERS.

Advertisements intended for insertion in the current issue should reach us on Wednesday morning at the latest.

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NOTICE TO NEWSAGENTS AND SUBSCRIBERS.

Numerous complaints having been made to us by Subscribers of the difficulty they experience in obtaining copies of the *Practical Engineer* in certain districts, we have to state that the Journal can be obtained by any Newsagent through the ordinary Trade channels, and no difficulty should therefore exist in obtaining copies by order of any Newsagent.

For the information of the Trade, we may state that copies can be obtained from either of our Offices in London or Manchester, or from any of the following wholesale houses, who are also supplied with Contents Bills for the use of the Trade:—

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JOHN HEYWOOD, Deansgate, Manchester.
ABEL HEYWOOD & SON, Oldham Street, Manchester.
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THOS. HAYNES, 6, James Street, Dock, Cardiff
R. SIMPSON, 38, Wilson Street, Middlesbro'-on-Tees
GEORGE BROMBY, 26, Charles Street, Hull.
EDWARD KING, 37, Greyfriars Lane, Coventry,
&c., &c., &c.

NOTES.

THE Sloyd system of manual training is in use at the Cambridge Training College for Women. Miss Hughes, the Principal, spent last summer vacation at the Sloyd Seminary at Naas, and now has undertaken to teach her students at the Training College. We may expect before long to find carpentering one of the recognised female occupations.

THE Guarantee Fund for the Glasgow International Exhibition has nearly reached the enormous total of £300,000. The arrangements for the Exhibition were recounted at a meeting held on Monday in that city. We may mention that the covered area will exceed by about 20,000ft. the space occupied by the Manchester Exhibition.

THE remarkable prosperity of the American anthracite coal trade last year had a very important bearing on the earnings and profits of the railway companies engaged in the business. The Philadelphia and Reading Railroad will, of course, suffer largely from the strike that is proceeding in the Lehigh Valley, but other companies, such as the Delaware and Hudson, and the Delaware, Lackawanna, and Western Companies, have rather benefited thereby, as they have been able to increase their own output, besides getting much better prices. Both these companies have earned a dividend of nearly 12 per cent., after allowing for considerable additions to operating expenses. We hear that the coal strike is causing so many furnaces to be shut down that a great deal of destitution is being caused among the labourers at the iron mills and ore banks.

THE Chancellor of the Exchequer had no doubt the usual sort of difficulty experienced by previous Rectors of the Universities, in selecting his subject for the Rectorial address at Aberdeen the other day. His choice fell on a subject that would be interesting to all business men as well as scholars, being applicable to every sort of work—the habit of intellectual interest in all that is studied, learnt, or done. Mr. Goschen pleaded for that absorbing interest in one's work which, he says, is characteristic of Germans, and, in fact, forms the chief difference between say a German clerk and an English one. While the former will discuss complicated questions relating to his work with the keenest interest and the utmost oblivion of the clock, the latter is only too anxious to get his release, that he may rush off to his cricket, or football, or boating, or other pleasure or pastime that may be in season. In this vein a comparison was drawn between the Englishman and German, intended to be very unfavourable to the former.

WE are glad, however, that in some respects the English clerk was conceded to be more attractive than even the German. In loyal devotion to the interests of his employer, for instance; in natural quickness and energy for special duty he has no superior; and further, who can blame him if he has other ties and pursuits independent of the workshop or counting office? Mother wit and boldness in seizing great opportunities are, according to Mr. Goschen, the chief factors in our previous successes, but they are now, he says, no longer sufficient to maintain our position in the race. It is a pity we were not told whether these two features were incompatible with one another or not, and if the latter, to what extent each was to be cultivated.

THE meeting of the Manchester Geological Society, held at the Literary and Philosophical Society's Rooms, 36, George-street, on Tuesday, the 7th inst., was wholly occupied by the reading and discussion of papers concerning the occurrence of boulders in coal seams, when some interesting facts were brought before the Society, and specimens exhibited. At the evening meeting, held at Owens College by the invitation of the Council of the Victoria University, Mr. Edwards read a very interesting paper on the fishes of the red sandstone, and generously promised twenty-four specimens of the same to the museum of the College, which was poorly represented in these fossils. The museum, however, when completed, will be the finest geological museum in the county. The nucleus was formed by the gift of the magnificent collections of the Manchester Geological and Natural History Societies to the College, and is now being arranged in the new museum buildings. Professor W. C. Williamson also addressed the meeting upon the stigmaria.

INQUIRIES UNDER THE BOILER EXPLOSIONS ACT, 1882.

Notwithstanding the somewhat harsh criticisms which were passed on some of the reports of the Board of Trade Surveyors, and the absurdity of denominating as "explosions" many of the trifling occurrences into which preliminary inquiries were made under the above act, when first it came into operation, it cannot be denied, on looking back over the reports which have been published by the Board of Trade, that they contain a great amount of useful and interesting information, besides having their amusing side. Prior to the passing of the act, the only tribunal for inquiring into the occurrence of a boiler explosion was the coroner's jury, than which, probably, none more unsuitable could possibly be found, composed as it mostly was of petty tradesmen, grocers, bakers, tailors, or others who could be found by a local police sergeant, with time to sit for a few hours in a neighbouring public house, presided over by a coroner who might know something of the law, but who, as a rule, was absolutely innocent of any scientific knowledge, and possessed none of the qualities whatever such as are necessary for the investigation of these occurrences. The conclusions arrived at were consequently almost always of an unsatisfactory character, and even if the stereotyped verdict of "accidental death" were not arrived at, the verdict was perhaps still more objectionable and mischievous through being misleading. The so-called "scientific" witness, called in by the coroner to report, was perhaps some old fossil local engineer whose sole idea about boiler explosions was what we have ourselves scores of times heard expressed—that these could not possibly take place if only the attendant would "keep plenty of water in the boiler." Hence it happened when the verdict was "accidental death" that the cause was frequently erroneously attributed to "shortness of water," whereas it is only too well known to experts that there is less proportionate injury to life and limb, as well as less damage to property, from failures arising from shortness of water than probably any other cause of explosion. When the victims of a boiler explosion happened to die in different parishes, or within the jurisdiction of separate coroners, each of whom had to summon a jury and hold an inquiry, it frequently happened that different juries brought in different verdicts; and where one might attribute an explosion to shortness of water, another jury, who might perhaps have the advantage of better engineering advice, called in by a more intelligent coroner, would place it on record that the cause of explosion was weakness of construction, or unsuitability of the boiler for the pressure carried, etc.

Since the passing of the act, something like 240 Reports of Preliminary Inquiries have been issued, and of these many have been of a really useful and practical character, containing much valuable information, and giving steam users and others interested in the working of steam boilers an opportunity of acquiring practical knowledge and information on this subject previously only obtainable through the large boiler insurance companies, who for a long time spent money in a praiseworthy manner in the investigation by their own trained experts of almost every boiler explosion which occurred in the United Kingdom.

We have referred to the amusing side of the Board of Trade Reports of Preliminary Inquiries, and those who have read the sapient remarks and comments in the "Observations" at the end of the reports, on the surveyors' conclusions, will readily understand to what we refer. It has been so often fortunate for the owner when no one has been killed or injured, that one would naturally expect something stronger than "this ought to be a warning" when serious damage and injury have occurred and life has been sacrificed through somebody's neglect or carelessness, or worse. So far, however, the Board of Trade officials have not availed themselves of the somewhat plenary powers conferred by the act to anything like the extent to which they might have done, especially with respect to what may be termed the penal clauses; and, with the exception of one or two instances where persons have been fined for not reporting the occurrence of a steam boiler explosion within the specified time, we are not aware of any punishment which has been inflicted under the act, in the way of saddling anyone with any of the expenses of inquiry, etc.

PLANING IN BOTH DIRECTIONS.

Mr. J. H. Wicksteed, of the firm of Joshua Buckton and Co., Limited, Leeds, writing to *The Engineer*, says that planing machines arranged to plane in both directions have been found to answer very well in their shop. This is directly opposed to the experience of Mr. Dixon, as given in his paper on Modern Machine Tools, reported at length in this journal. Mr. Wicksteed says that for "large plane surfaces of cast iron, such as stationary engine bed plates, beds of lathes, planing machines, and, in fact, the bulk of heavy planing in engineering works, the advantage of planing on both strokes is so obvious in principle that it does not require demonstration. But besides the effective use of time during the return stroke, the system, if carried out with two back-to-back tools, has the incidental advantage of only wearing each tool, in traversing over a given surface, half as much as it would be worn if its companion did not divide the work with it. Again, there is an incidental advantage in the circumstance that each tool chips away the end skin from the casting, and makes clean metal for its companion to enter. Any engineer having large surfaces to plane would find that the cost of the necessary additions which would enable him to have a machine constructed suitably for double cutting, or to have an existing machine, if a good one, adapted for double cutting, would be repaid in a month's working." We have seen Messrs. Buckton's planing machines, and may take this opportunity of saying that we were agreeably surprised at the success that had been attained in their introduction. Mr. Dixon's strictures are, we believe, quite applicable to the revolving tool box.

TRANSMISSION OF POWER.—II.

BELTS.—II.

M. Leloutre, in a continuation of the paper from which we made several extracts in our first article, gives some interesting particulars respecting the slipping of belts.

He found that the coefficients of friction between belts and cords and the polished surfaces of pulleys, which are used in many formulæ, are two or three times too great. His experiments furnish minimum values for the coefficients of friction, and higher values can only lead to error, and are of no practical utility.

The experiments were very varied. Pulleys 4in. to 8ft. in diameter, with flat or rounded faces; belts $\frac{3}{8}$in. to 12in. wide;

arcs of contact from 180° to 1260°, or $\frac{1}{2}$ turn to $3\frac{1}{2}$ turns round the pulley; and tensions ranging from below to much above those employed in practice. The trials of hemp and cotton cords comprised sizes varying from sewing thread, twine, cords $\frac{3}{8}$in. or $\frac{1}{2}$in. diameter, to ropes $1\frac{1}{4}$in. diameter; and the pulleys were plain or with V-shaped grooves.

The results are given in the following table:—

TABLE I.

Nature of Material.	Coefficients of Friction.
1 Dry new leather..........................	·155 average
2 Old greased belts on well polished pulleys	·200 to ·220
3 Old greased belts on rough pulleys.........	·300 to ·330
4 Moist new leather	·120 min.
5 Ropes, cords, twine, and sewing thread	·070 to ·075

The friction was independent of length of the contact of the pulley and the belt, or of the area of the contact surface, and change of temperature between 10° F. and 77° F. seemed to produce no effect.

HOT AIR ENGINES.—II.

(Continued from page 4.)

One of the principal reasons why hot air engines have, up to the present time, been heavily handicapped, is that they take up so much room for the amount of power developed. In general theoretical considerations of the action of heat, the time which it takes to heat or cool any particular agent is not borne in mind; and, unfortunately, in using air, an agent is dealt with that is very slow to receive an increase in temperature, or to become cooled again. Air has the further disadvantage of being diathermanous, that is, allowing radiant heat to freely pass through it; so that the only way to heat or cool it is by actual contact. Comparing air with water, the former would require, if heated externally in a boiler, about five to ten times as much heating surface as the latter to obtain the same rise in temperature in equal times. Another property of air, its incondensibility, makes it difficult to obtain the best results, as it cannot be treated like steam in a condenser. This latter property, however, is of advantage in the cylinder when it is doing its most useful work.

Internally fired air engines, where the air is partly heated by combining with the coal gases to produce combustion, are on the other hand superior to steam engines in the directness with which the working agent is heated by the fuel. Again, the smoky and yellow flamed products of combustion are better radiators than the blue flamed products of perfect combustion, and the latter are not the most advantageous for raising steam. On the contrary, in an internally fired air engine, the more perfect the combustion, the more air will be used to produce it, and a greater temperature will be obtained, and the highly heated air will mingle freely with that at a lower temperature, thus imparting its heat to the air passing over the furnace.

The first noteworthy hot air engine was constructed by Stirling, for the Dundee Foundry, about the year 1827, and embodied for the first time the idea of a regenerator, that is, a mass of matter for storing and restoring heat. The general construction was that of the ordinary beam engine, but in place of the boiler there were two heaters, provided with regenerators, and having displacing plungers in them worked from opposite ends of an auxiliary beam, driven from the engine, and an air supply pump in place of the boiler pump, for making leakages good.

Fig. 1 will represent the heater and cylinder sufficiently in detail for the purposes of explanation. H, G, B, is the heater, with a plunger F, regenerator at G G, in plunger, refrigerator H H, with water circulation, and furnace B. C represents the motive piston in the cylinder of the engine. The crank for driving the plunger F is a quarter of a revolution in advance of that driven by the piston C. The action of the engine is as follows:—With the plunger F at the top of the heater, most of the air is near A, and over the furnace B, and consequently becomes heated; it therefore expands, and drives the piston C from the bottom to the top of the cylinder. The plunger F then descends and forces the air through the regenerator G, giving up heat thereto, and finally to the refrigerator H, where the cooling of the air is completed; this cooling produces a contraction in the bulk of the working air, and allows the piston C to descend. The piston C is therefore actuated by the alternate expansion and contraction of the same body of air. With two heaters one is in connection with the bottom, and the other with top of the working cylinder.

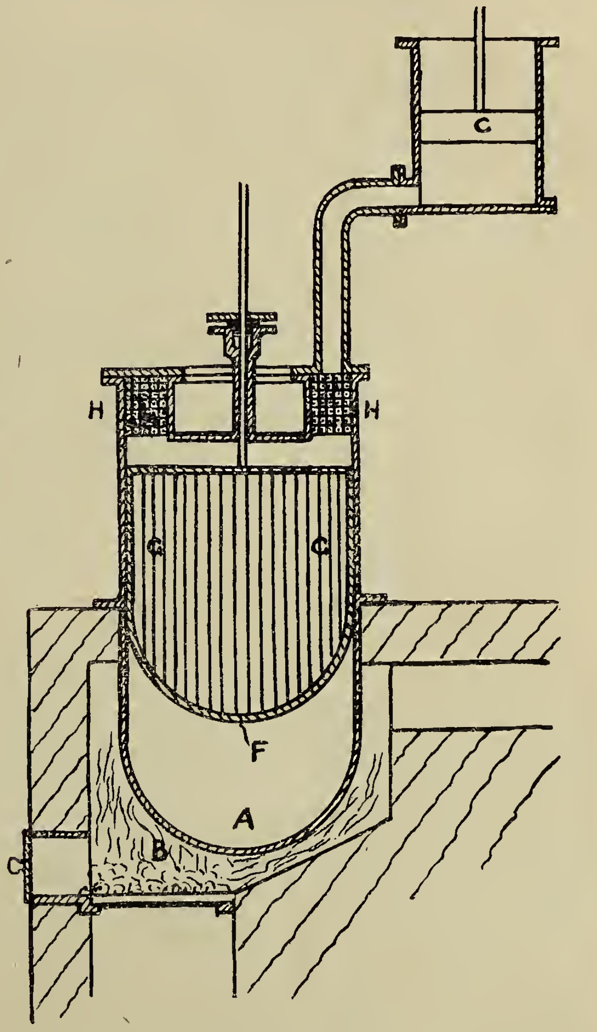


Fig. 1.

The engine at Dundee had a double acting cylinder 16in. diameter × 4ft. stroke, and made 28 revolutions per minute; the brake H.P. was $45\frac{1}{2}$, with a friction of $\frac{1}{9}$th of this amount; the greatest temperature was 650° F., and the lowest 150° F.; the cooling water was raised 16° to 18°, with a supply of 4 cubic feet per minute; heating surface 75 square feet; 1,000lb. of coal were used in 12 hours. The consumption of coal per brake H.P. was therefore 1·9lb. The furnace was 24in. × 22in. The bottoms of the heaters were worked at a dull red heat, or 1200° to 1300° F., with a pressure of air between 160lb. to 240lb. per square inch.

The results obtained were excellent for the times, and good as compared with present performances, but after all manner of experiments in the method of heating the heaters, the engine had to be abandoned on account of the rapid destruction of the heater bottoms.

It will be noticed that the engine ran very slowly, and the highest temperature of the air was only half that of the bottoms of the heaters, but this temperature would not have been reached if the air had been worked at a less density. The regenerator in the first engine was composed of numerous horizontal layers of thin sheet iron, with holes punched through them, so as to leave a big burr round the edges of the holes forming the distance piece between the plates. The latest form of regenerator consisted of alternate vertical plates of plain and fluted glass. The air in all cases passed through perforations in the top and bottom of the plunger, on its way to and from the regenerator.

HAND SAW FOR IRON.

An improved saw for cutting iron, which appears likely to prove of great utility to mechanics and others, was recently shown to us, and may be new to some of our readers. The article, which is called the "Star Hack Saw," is of American manufacture, but may be obtained from probably most ironmongers. The improvement is in the saw blade itself, which has teeth of fine pitch, with a little set on them to give clearance, and sharpened at an angle in alternate directions, exactly like the teeth of a joiner's dovetail saw. The temper is also so hard that the teeth when once dulled cannot be sharpened in the ordinary way, and the blade is rendered useless, and may be thrown away. A new blade may, however, be put in at less cost than would be incurred in sharpening a saw of the old type, the price of 8in. blades being 2s. 6d. per dozen. The frame is similar to those hitherto used, with some slight improvements for facilitating the insertion of the saw. The performance of this tool is remarkable. A railway metal is stated to have been cut across with a 10in. saw in less than two hours; and the writer, with an 8in. saw, cut through a wrought iron pipe ¾in. bore in three minutes, and through a ⅞in. square iron bar in five to six minutes. From its use a considerable saving in time and files should be effected.

MODERN MACHINE TOOLS.—IV.

(*Concluded from page 56.*)

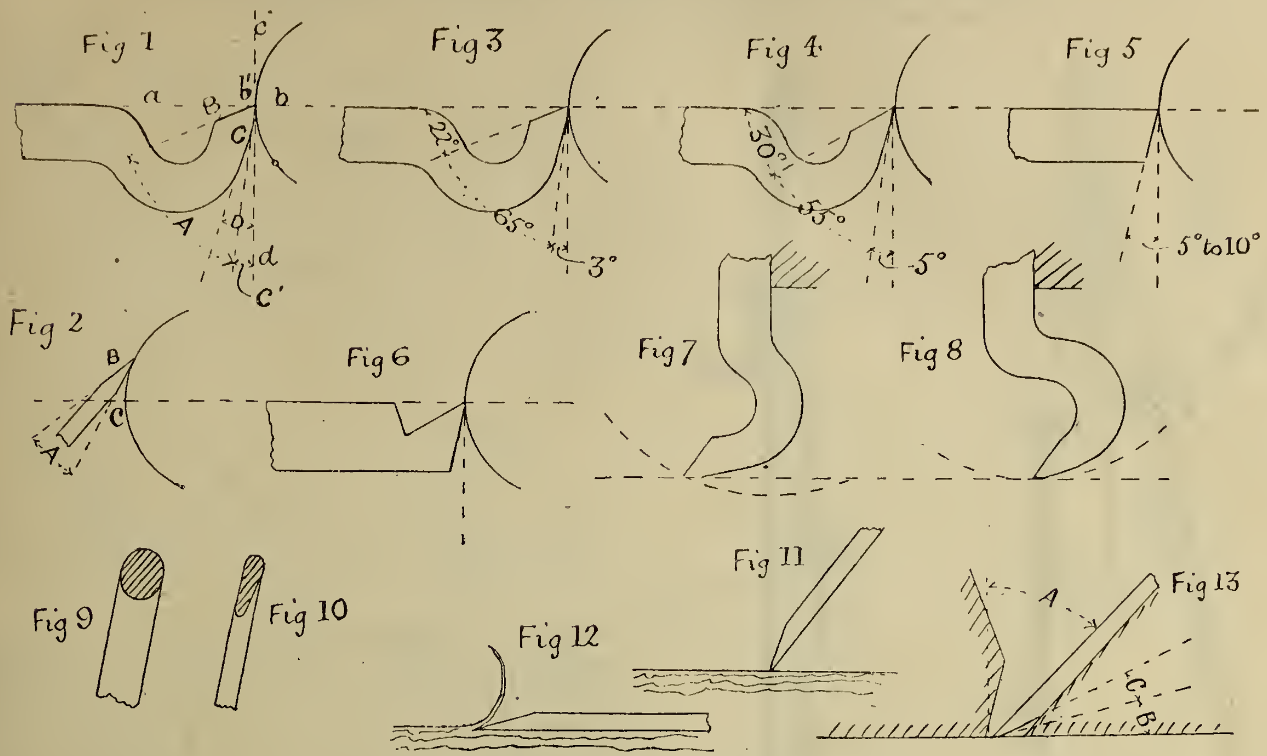
In boiler making they had an industry which but a few years ago was comparatively one of the most primitive branches of engineering, but to-day, in the best workshops round Manchester, they had now a highly specialised branch of engineering. The demand for boilers carrying high pressures had necessitated the introduction of special machines, and another important step had been the introduction of steel plates, giving, as it did, the capacity to produce plates of almost any size, so that to-day, they found plate-planing machines adapted for plates up to 30ft. long, and rolls to correspond for bending plates up to 1½in. thick. In addition to the many special machines adapted to particular types of boilers, such, for instance, as the flangeing, and the turning and drilling of the Adamson flues, the Galloway tube, etc., we had numerous machines adapted for various types of boilers. Where, formerly, with iron plates and low pressure, the punching of the rivet holes was considered quite sufficient, to-day, with high-pressure and steel plates, the boiler maker could not afford to run the risk of damaging a steel plate by punching, and his reputation by the consequences which would arise from a flaw escaping undetected. When the demand was first made for having all rivet holes drilled when the plates were in position, it was considered to be an enormous increase upon the cost of a boiler, and doubtless the primitive appliances then available for drilling the shells, flues, etc., were highly suggestive of such a result. With the demand had been a rapid development of special machines for this purpose, commencing with the simple radial arm drill, then the two-headed horizontal drill of independent action, with the boiler shell suspended from the crane. This machine necessitated the marking out of the plates. The next step was with three horizontal drills around a circular table, upon which the shells were mounted and divided circumferentially by mechanical means. This machine was improved considerably in detail, and gave good results, but one of the latest was a machine in which six drills, all under the control of one man from a single position, were in operation either upon the circular or longitudinal seams: so that the cost now of drilling a boiler is no more than that of one with punched holes. In connection with constructions in wrought iron and steel plates, he would stop for a moment to note that highly important family of hydraulic tools so developed in recent years. Though the principles first applied by Bramah about the beginning of this century remained the same, there had been a wide application and great improvements in hydraulic appliances, especially for riveting, flangeing, and heavy shearing and punching machines. This highly concentrated form of hydraulic pressures had proved the most convenient form of applying heavy pressures, and we had to-day some of those useful portable riveting machines adapted for almost every form of construction, and we had an interesting series of machines up to those extremely powerful shearing machines for cutting slabs in steel, as much as, say, 10in. thick, and 30in. wide.

One other point upon which he would remark was the great importance of a thorough study of the cutting tools. Formerly it was the custom of almost all workshops to permit each workman to construct or superintend the construction of his own cutting tools. This, with the varying degrees of intelligence possessed by a body of workmen, and the varying opinions upon the same points, led to the greatest confusion, and a general collection of cutting tools was, perhaps, one of the greatest medleys possible. A thorough study of the correct cutting angles for different materials had led to the possibility of much greater system being carried out in workshops where standard sizes and forms of tools were employed, and which permitted of the interchangeability and sharpening of all tools being performed by an independent man for a whole series of workmen. The special adaptation of almost all machine tools to the particular requirements of each workshop has been brought about by machine tool construction having become a highly special branch of engineering, to which many engineers have specially devoted themselves, and which permits such experienced men, from an inspection of any piece of work, to say almost instantly what is the best method of proceeding, and from their special knowledge of the adaptability or combination of the whole families of machine tools, to prepare quickly any desired modification to suit a particular work.

TOOL ANGLES.—II.

But, besides the essential angles, there are several points about these roughing tools which are worthy of note. The "cranking" is effected for a twofold purpose. In the first place, the hollowing out of the metal behind and below the top face permits of more efficient grinding, the narrow independent cutting face being easily reground without the making of a sharp angle as in fig. 6, which would be inconvenient, and a source of weakness. Through cranking, also, the tool point is placed in a favourable position in relation to the shank, a matter which, though of less importance in the case of lathe tools turning circular work, is a vital point in the roughing tools of planing and shaping machines cutting plane surfaces. Should the tool in fig. 7 catch in the work during a heavy cut, it would dig deep below the surface, because it would be thrown backward in the direction of the dotted radius. But in fig. 8, the tool being cranked backwards, the tendency is not to catch, but to be thrown off clear of the surface. Though in lathe tools, therefore, the cutting face is usually kept about on a level with the top of the shank, in tools for planing and shaping machines it is kept in a line with the back of the shank, as in fig. 8. Further, there are two bevels on the bottom face of the roughing tool, see fig. 1, C′ being the true cutting bevel, and D a reserve, so to speak, which being drawn upon when regrinding, saves the unnecessary labour of going over the whole face. Take again the cutters used in tool holders for metal turning. These are pieces of round rod ground off at an angle (fig. 9), or triangular pieces (fig. 10) similarly ground off. The angles given for these are similar to those given for solid tools, but the clearance angle is provided by the leaning forward of the cutter itself, so that nothing but the bevelled cutting face is ever ground. It will be observed that, grinding in a flat plane instead of hollowing out the face, all tools, whether of this kind, or solid, can only truly cut on their very points; so that when they are presented to the work in positions a little to right or left of those points, the proper cutting angle is virtually lost, while farther round at the sides it is absolutely *nil*. Hence the reason why all solid tools, like fig. 1, are not only made straightforward, but right and left as well, and why cutter holders also are made right and left

TOOL ANGLES.—II.



handed, or are constructed to swivel round to any required angle. Few tools are more generally useful and adaptable than the common graver. It is the sheet anchor of the hand turner in metal work, being used for any metals, according to the angle given to the bevelled portion. For iron this should be about 45°, and then the angles of the right and left hand cutting edges will be 60°, which is a medium between figs. 3 and 4. If we take the common chisel we find that to obtain the best results it needs to be presented absolutely at a tangent to the work, that is, parallel to the face. If the chisel were presented as in fig. 11, it is clear that it would lack both guidance and strength, and would be quite inoperative in consequence. It would neither cut nor scrape, and supposing it were thrust along forcibly in a guiding stock, like a plane iron, its edge, having no backing of metal, would became notched immediately, unless indeed it were kept at a low angle, which in fact is done with some iron planes, the face angle being about 15°, and the top face bevelled. But holding the chisel as in fig. 12, the lower face becomes a guide to the cutting edge, and the mass of metal behind sustains that edge, notwithstanding its almost razor-like keenness. The same principle holds good of the axe and the adze, the bevelled edge in the first case, and the curved face in the second, acting very nearly tangentially to the surfaces which they reduce. With the plane the principle is modified somewhat; the top or cutting face of the iron is inclined at a uniform angle of from 45° to 55° with the face of the material being operated upon, and at this angle the iron would dig into the material but for the very important fact that the stock becomes the guide, coercing and preventing the iron from penetrating beyond the depth to which it is set beyond the face of the stock. An angle much lower could not be given to the face of the iron, as the cutting angle would have to be reduced in proportion, and then it would not be strong enough to stand the strains, shocks, and general rough usage to which it is subject. Even as it is, an exceptionally hard, harsh, rough, gritty, or knotty board puts the patience of the carpenter to the test. Moreover, if the angle were diminished it would be quite impossible to plane crooked grain, for the iron would have a greater tendency to dig into it and tear up the wood. Even as it is, for the harder and more crooked woods it is often necessary to use planes having irons set at a greater angle or "pitch," and to finish the surfaces by a process of scraping pure and simple. In the plane also we see the selfsame principle of construction as in the metal cutting tool, fig. 1. There is the angle of top rake A; fig. 13; the clearance angle B, produced by the sharpened facet; while C is the reserve drawn upon for sharpening, and the metal included between A and B is the cutting angle, or angle of the tool.

UTILISATION OF HEAT IN THE MARINE ENGINE.

On Monday, the 6th instant, the Hull and District Institute of Engineers and Naval Architects held their sixth general meeting of the session at the Mechanics' Institute, Hull, C. D. Holmes, Esq., being in the chair. A very interesting and exhaustive paper was read by Mr. J. R. Smith on "An inquiry into the most efficient method of further utilising heat in the marine steam engine." The writer in his paper drew attention to the three great successful revolutions in marine engine practice, that had taken place during the last thirty years, viz.: (1) The introduction of surface condensation; (2) the introduction of the compound engine; (3) the introduction of the triple and quadruple expansion engine. In the course of his remarks he went very fully into the theory of the steam engine as a heat engine, illustrating his remarks with diagrams. He commented upon the influence of clearance and initial condensation, and gave as the means of further utilising heat between the boiler and the condenser—(1) increase of initial temperature obtained by increase of pressure; (2) increase of initial temperature obtained by superheating; (3) increasing temperature by jacketing; (4) decreasing terminal temperature in the condenser. After touching briefly upon the principle and possible benefits got by the feed heaters of Messrs. Weir and Kirkaldy, he entered into the question of further utilising heat by the addition of an ether cylinder, evaporator, and condenser, to the present triple expansion engine, thus converting the said engine into a binary vapour engine.—The paper was discussed by Messrs. C. F. Amos, A. N. Somerscales, J. H. Leetham, Geo. H. Strong, and J. Jamieson, and the discussion will be renewed at the next meeting.

Working Blast Furnaces with Natural Gas.—According to the *American Manufacturer*, Mr. Jacob T. Wainwright, a Pittsburg engineer, has at length succeeded in making pig iron, using natural gas as a fuel. The difficulty which has hitherto prevented the use of gas for this purpose was the necessity of supporting the ore and fuel in the furnace, an office previously performed by the coke. In the new furnace this is done by a series of pipes protected with fireclay tiles. The pipes are kept cool by turning a portion of the blast into the space between them and the tiles. The furnace is fitted with a combustion chamber, into which the gas and air, furnished from an ordinary cupola, are admitted through separate pipes. Ordinary cupolas, it is stated, may be easily altered to use the new fuel.—*Engineering*.

THE "BENNETT" GEOMETRIC COMPASS.

MANUFACTURED BY J. F. BENNETT AND CO., ELLIPSES WORKS, SHEFFIELD.

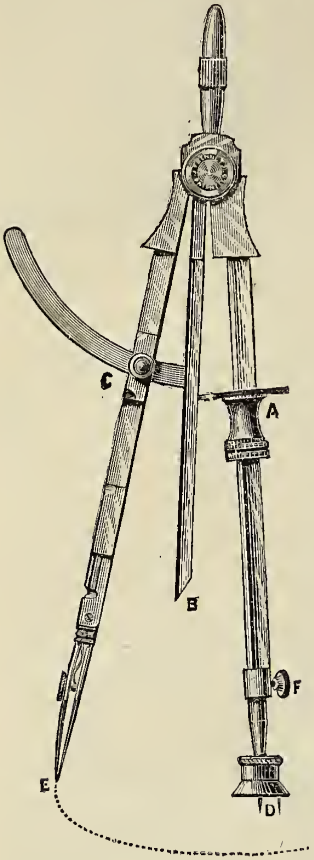


Fig. 1.

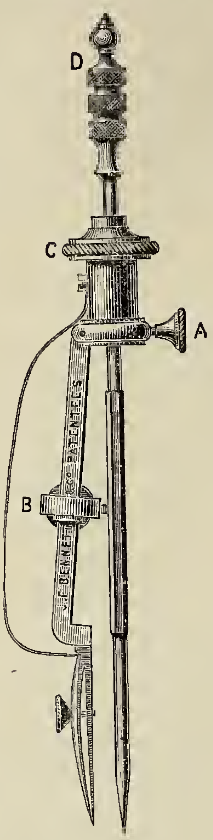


Fig. 2.

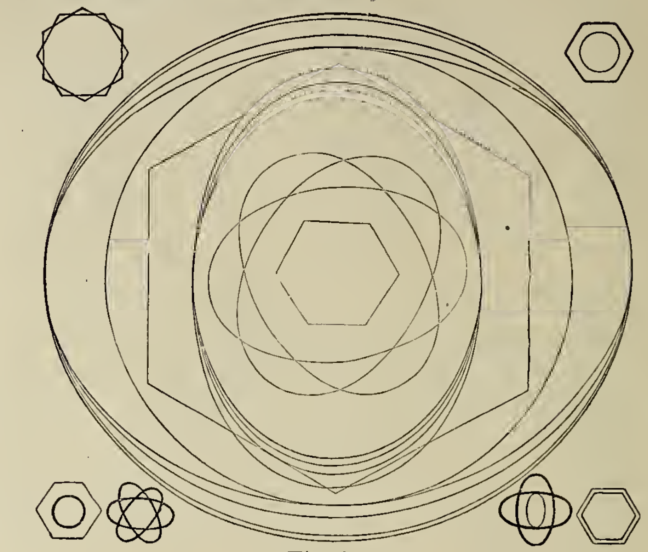


Fig. 3.

All draughtsmen are well acquainted with the laborious and very unsatisfactory methods of drawing ellipses, and as a consequence freehand sketching is often resorted to when the figure is not a large one, a process that, however neatly done, spoils the appearance of the sheet. The higher orders of polygons, as octagons, decagons, etc., are sometimes required to be drawn, and although these can be accurately executed with the ordinary tools, yet the time occupied is very great, and frequently leads the draughtsman to wish for some more expeditious plan of drawing them. We are pleased to notice that Messrs. J. F. Bennett & Co., Ellipses Works, Sheffield, have introduced a patent compass which entirely meets the want above indicated, and in such a manner as to readily commend itself to everyone. The compass is illustrated in our engravings herewith, two forms being shown. Both can be used as ordinary compasses if desired, and transformed again into elliptical instruments in a moment. Looking at fig. 1, it will be seen that the foot of the right leg has two points which are pressed into the paper, the centre one marked D being placed in the centre of the figure to be drawn. The leg itself has a ball joint which revolves freely in the stationary foot. A templet A moves up and down the leg, and the shape of it determines that of the figure drawn by the compass ; this templet is removable and may be replaced by an octagon one, or any other shape desired. The rest of the compass will be understood from the engraving. The method of operating is described as follows :—

To describe circles :—Lower the templet A until it clears the central leg B, and set the radius by means of quadrant C. Circles are then obtained as with an ordinary compass.

To describe an ellipse, the major and minor axes being given : Fix the point D in centre. Place the pen point at extreme major axis required ; rotate the templet A until the engraved line on its surface is in line with the sharp edge of central leg and the major axis and pen point ; secure F, rotate the pen, and place its point at the extreme minor axis required ; secure screw C (this gives the minor axis of ellipse), rotate the pen until its point touches the major line, then elevate or lower the templet until the pen touches extreme major axis. If the instrument be now rotated the exact ellipse desired will be described. It is not necessary to have a separate templet for every variation of ellipse, as by simply elevating or lowering the templet A, the major axis of an ellipse is elongated or shortened to any point required, the minor axis remaining unaltered. On the other hand, the minor axis is increased by lowering the templet until the pen point shows the major axis reduced the extent by which it is required to increase the minor axis. Extend and fix the pen at the original major axis, and on rotating the compass the ellipse desired is completed.

To describe polygonal figures:—Replace the elliptic templet by a model of the polygon required, and follow in general the directions for striking an ellipse. The figures may then be drawn as freely as ellipses.

Care is requisite, of course, in manipulating the compass, it being necessary to press *lightly* on the pen, and to draw evenly in one direction. When drawing hexagons, etc., the corners must be turned slowly, and the angles are then drawn perfectly acute.

The compass shown in fig. 2 is of a different construction ; here the templet is formed by the leg itself, which can be changed when different shaped figures are required, by simply unscrewing the handle D, when the leg may be drawn out, and replaced by the one desired.

To describe circles with this compass.—Fasten the screw A and elevate slide B until the radius required be indicated by pen ; then draw as with an ordinary bow compass.

To describe hexagons or ellipses:—Loosen the screw A and elevate or lower the slide B until the size of figure required be indicated by pen. Hold the compass in the left hand by the handle D, and then revolve the pen by means of milled-head C. A fac-simile of the leg will now be produced. Any figure is increased or lessened in size simply by elevating or lowering the slide B, and a large variety of figures may be produced either parallel or at different angles with each other, all from *one* stationary leg. The central figures shown in fig. 3 were drawn by the first instrument (fig. 1) in a few minutes, without once removing the foot of the compass from the paper ; those in the corners were drawn by the bow compass, fig. 2.

H.M. Science and Art Department have placed these instruments on their prize lists, thus signifying their approval of them, and we understand that they have already met with great favour in mathematical and technical circles. We can certainly recommend them to all draughtsmen, designers, and architects.

Obituary.—Mr. James Caird, engineer, shipbuilder, and senior partner of the firm of Caird and Co., Greenock, we regret to say, died suddenly on Monday week. Mr. Caird was not only a shipbuilder, but also an originator of many improvements in marine engines. In early life he was associated with Mr. Scott Russell, and to their joint efforts the Royal Mail Company were indebted for their earliest steamers. Some of the finest ships in our mercantile marine now afloat have been built by the firm of Caird and Co. during the time he has been at its head. By his death the shipbuilding trade has suffered a serious loss.

THE USE OF CAST STEEL IN LOCOMOTIVES.—III.*

Continued from page 43.

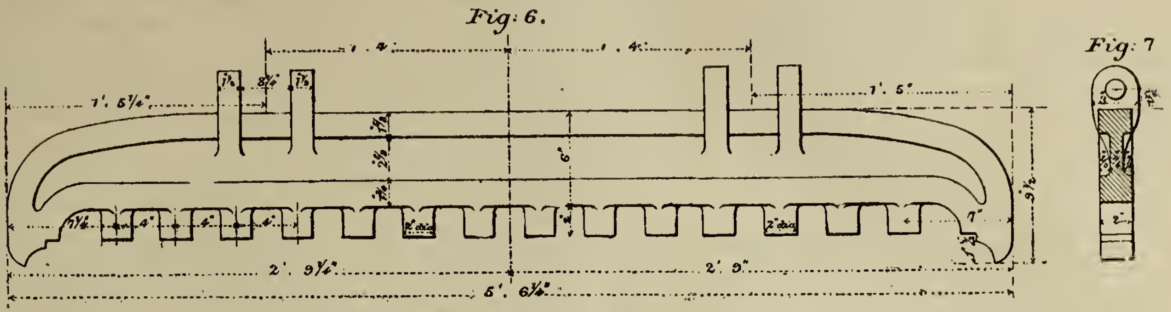


Fig: 6. Fig: 7

FIRE-BOX ROOF STAY.

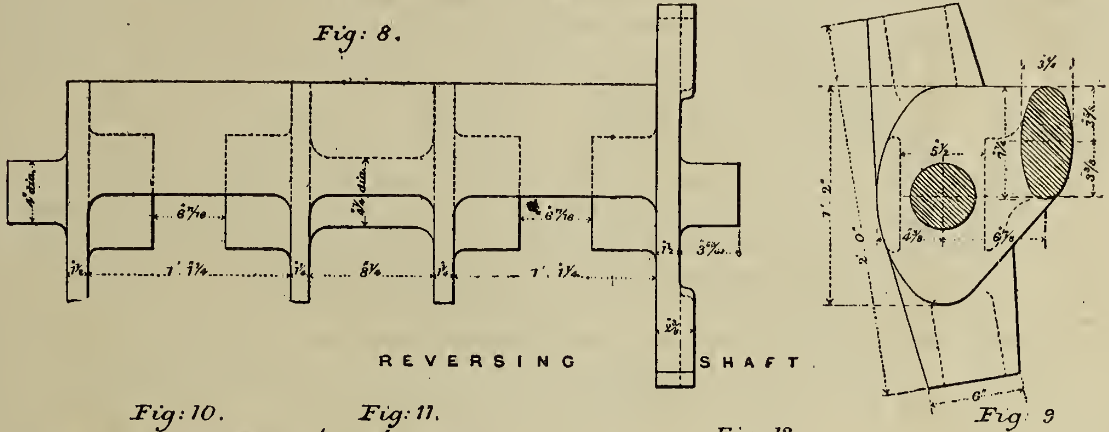


Fig: 8. Fig: 9

REVERSING SHAFT.

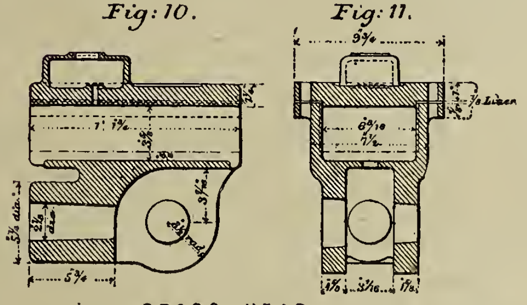


Fig: 10. Fig: 11.

CROSS-HEAD.

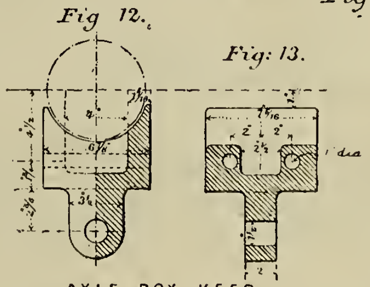


Fig 12. Fig: 13.

AXLE BOX KEEP.

Figs. 6 and 7 represent a cast steel roof-stay bar suitable for the boiler of a standard goods engine. Such bars are of the girder section, being ¾in. thick in the centre, and 2in. at the top and bottom; there are fourteen lugs or bosses, drilled and tapped, to receive the 1in. stay bolts; these lugs are 2in. in diameter, and about 4in. from centre to centre; the total length of the bar is 5ft. 6¼in.; the surface fitting to the box is planed, and the corners of the bar are also machined. There are eight of these bars to a set; the four centre ones are 6in. deep, and have double eyes cast on the top, from which they are connected to the firebox shell by sling stays; the four outer bars are cast plain on the top; the outside ones are 6in. deep, but the inner ones are 7in. deep. Each of these bars is tested before use in the following manner: The corners of the bars are supported on pieces shaped like the corners of the firebox, and pressure is then applied by a hydraulic press at the middle of the bar, the amount being 15 tons for the 7in. bars, and 10 tons for the 6in.; the deflection is found to be 1/16in., and they invariably return to their original form.

The adoption of Joy's valve gear for locomotives necessitates a somewhat complicated reversing shaft, and a steel casting was therefore most suitable (figs. 8 and 9). The ends of the shaft are turned to 4in. in diameter, and then fitted into cast iron brackets by which it is carried, these being bolted to the frames; no other surface of the casting is itself a working part, as wrought iron slippers are fastened to the cheek by two 1¼in. bolts, phosphor-bronze motion blocks working in these slippers. Bridge pieces are cast across between the cheeks, and are slotted out; one of these pieces, pieced, has been in use as a lathe tool with very fair results.

Engines which are fitted with two or four slide bars have a simple form of crosshead, but when only the single bar is used this is more complex. These crossheads (figs. 10 and 11) have been tried both in wrought and cast iron, but cast steel has now been adopted. There is no bearing on the casting itself, but the side bearing is taken by phosphor bronze strips, three of which, about ¾in. thick, are dovetailed into each side of the casting, so that they can be easily taken out when worn, and others substituted; the bearing at the top is taken by a cast iron cover, bolted to the main body by six ¾in. bolts; a cast iron liner is also fitted to the bottom, being fastened by three ⅝in. set bolts. The crosshead above described is used for passenger engines, express, tank, and goods engines; about twenty of them are now running with good results.

In engines with underhung springs there is necessarily a great strain on the axlebox keeps, and for this reason steel castings are especially suited to obtain the maximum strength with the minimum weight. Figs. 12 and 13 represent a keep suitable for a shunting tank engine, with a lug cast on from which the springs are hung; the greatest weight carried by a lug is 7 tons, and as the sectional area is two square inches the strain is 3½ tons per square inch; of course a large factor of safety must be used on account of the sudden jars, etc., to which it is subjected by passing over points or irregularities in the permanent way. Besides the details illustrated and described above, various others are now being made in cast steel, the chief being bogie centres and slides. These were originally made of cast iron, and a thick india rubber washer was inserted between the castings to deaden the effect of jars, but the very high price of india rubber rendered this an expensive arrangement, and it is found that by using steel castings the india rubber is unnecessary. Frame stays of various forms are now being made of cast steel; also platform brackets and gusset plates, all of which give good results. The spring hangers and brackets for tenders are also steel castings, and the author understands that efforts are being made by a Sheffield firm to have the spring buckles made in this way. Cast steel horn-blocks have been under trial in locomotives for some years, the main objection to their use being that the surface is hardened by friction to such an extent that they are extremely difficult to repair, wearing the files out very quickly. The author is not aware that cast steel brake blocks have been tried in this country, either on engines, carriages, or wagons; but an alloy of cast steel and cast iron has been used on the continent. The advantages of this material, given as the results of a four years' trial, are said to be:—(1) A saving over wood in manufacture of 31 per cent. in wagons, and of 39 per cent. in brake vans. (2) The tires do not have flat places worn on them, which lessen the wear of the rail as well as of the tire. (3) The damage done to axle-boxes by these flat places is also prevented. (4) There is less danger of heating the tires, and the blocks cannot catch fire. (5) The mechanism of the brake can be simplified, as the levers need less frequent adjustment. (6) The life is increased from 120,000 miles for wood to about 200,000 miles.

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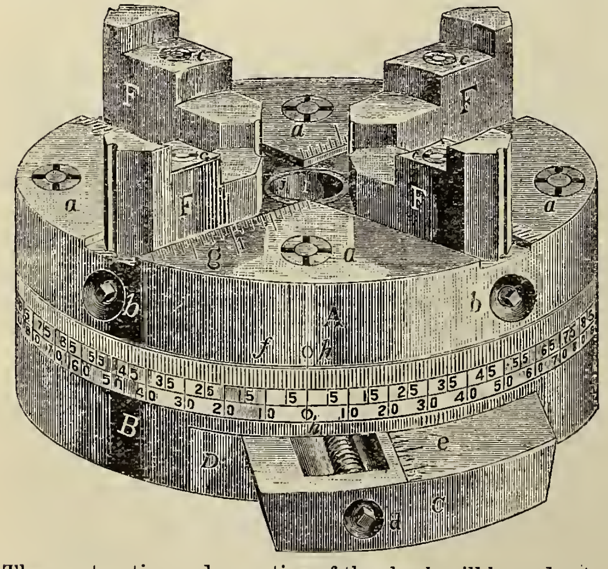
* Paper by A. J. Hill, Wh. Sc., read at a meeting of the Students (Inst. of Civil Engineers), and awarded a Miller Prize in the Session 1886-87.

One or two tools may now be mentioned which are made of cast steel. Every locomotive engine is provided with a set of tools, among which is a lifting jack, commonly called a bottle jack, and for the bottle or case a steel casting is very suitable; among these tools also is a set of spanners, which can with advantage be steel castings, owing to the varied forms in which they are necessarily made to get at the different nuts, etc.; engine ramps, for getting engines or vehicles on to the road again when they have accidentally been derailed, are almost always made of cast steel; and a large amount of punching, etc., is now done under hydraulic presses, and for the heaviest of this class of work cast steel dies may be economically used.

It is very desirable that the patterns from which steel castings are to be made should be of iron, especially if many castings are to be made from them, as they have to be rammed up very hard, and it is therefore almost impossible for a wooden pattern to stand long.

COMBINATION CHUCK.

The illustration herewith shows a lathe chuck, in which a piece can be worked, either concentric or eccentric, and in which any desired point on the piece being turned or bored can be accurately and quickly brought into a central position with the mandrel of the lathe, without shifting or loosening the piece in the chuck.



The construction and operation of the chuck will be understood from the following, for which we are indebted to the *American Machinist*:—A represents the front portion of the body of the chuck, to which the jaws F are attached by means of bolts C, having screw nuts on the outer end, for convenience of reversing the jaws. The inner ends of the bolts are T-shaped, and take bearing on the inner side of part A, and are driven forward and backward by independent screws, *b*, which work through bolts, *c*. B represents the rear portion of the body of chuck, which is so constructed as to lock over the part A. The locking joint is fitted slightly bevelling, so that when drawn tightly together with bolts *a*, the parts become perfectly solid. The bolts *a* have on their outer end a screw nut. The inner ends have a T-shaped head, which fits into a circular T-shaped groove, formed in the part B, which, as shown in the cut, is graduated into degrees, each of which is equal to 1-360th part of the entire circumference of the chuck. By loosening the nuts on bolts *a*, the index point on part A can be set to any desired division of the circle.

The sliding plate C is dovetailed through the rear side of part B, and clamped in any desired position by gib D, having tightening screws with countersunk heads. The sliding plate C is graduated into fractional parts of an inch, as shown at *e*, on each end, and adjusted by the driving screw *d*, which runs through the entire length of the plate C, working through a threaded nut well secured to part B, centrally located, in order that the sliding plate may have an equal adjustment in either direction, which in a 6in. chuch is 2¼in. The face of the chuck is also graduated into fractional parts of an inch, as at *g*, and on the same side and at the same distance from joint of each jaw is a vertical line, in order that each jaw may be readily adjusted to the same radius.

When the chuck is concentric, the orifice I extends entirely through the chuck. The sleeve J is securely fitted in the centre of the chuck, and forms a bearing for the inner end of driving screws *b*. As is shown by the figure, the cylindrical graduation commences at *o h*, and runs to 90° each way, making 180 graduations, so that the chuck is graduated exactly half way round, thereby enabling the operator to accurately rotate his work to any desired degree or division of the entire circle; and by the use of the graduated sliding plate C (which is secured to the mandrel of the lathe in the ordinary way), any point within the range of the chuck may be quickly brought to the centre of the mandrel of the lathe, or the position of the piece being worked may be changed to any extent without loosening the work in the chuck, until the turning, or boring, is completed. The jaws F are made with biting surfaces on each end, and can be easily reversed when so desired.

AN ENGINEER'S LIFE AT SEA.—II.

BY A SEA-GOING ENGINEER.

(Continued from page 21.)

As soon as 12 o'clock comes, day or night, the third engineer goes on duty. His first care is to go round the engines to ascertain if all working parts are keeping cool, if the bilge pumps are at work, if the water is well up in the gauge glasses, if the firemen have relieved each other properly, and if all is in order in the stokehole. He must see if the oil boxes are full, and the lamps burning brightly. He must also go to the stern gland through the tunnel, to make sure that it is cool, and on the way up must see that the thrust block is not heating. He may also have to use his wits to prevent tricks being played upon him by the one whom he relieves, as sometimes affairs get unaccountably wrong as soon as the other has gone, and then upon him will rest the duty of putting them right. A common trick is to pour water on the plunger of the feed or bilge pumps to give a false idea of them being cool, or to make them suck in cold water through their pet cocks, that the tyro may imagine them to be properly working when they are not. It is therefore best to leave these pumps to be examined last, so that they may return to their normal condition before examining them. These and many other illusions one, in time, gets an adept at detecting; but on the first watch no one will try to impose on our tyro, and for the credit of engineers it may be added that it is a rare occurrence for anyone to try to pass on anything seriously out of order, for each knows well that when anything of serious import occurs every engineer has to turn out to put it right.

The third will relieve the second, or the chief, as may have been arranged by the latter when setting the watches, and he goes with a parting injunction to be sure and call him should anything go wrong, or anything happen which is not well understood by the inexperienced one, who now finds himself left alone. The departing feet disappear up the ladder, he experiences a strange feeling of desertion. He is as one in a haunted room, surrounded with visionary possibilities of all kinds of disaster to the engines, or to himself. He takes another look at the labouring monster beside him, but it is intent upon its work and makes no movement of recognition. He sees the crossheads flashing up and down with steady beat, with the pendulum swing of the connecting rods below, while in their strong grasp the cranks swiftly and ceaselessly revolve. The restless forces at work give our third a feeling of companionship during these midnight hours, though he likes also to remember that the firemen are not far off.

After seeing that all is working well he must try to familiarise himself with the engines from every point of view. They are quite different to the same engines at rest, and from every new point of view they appear in a new aspect. From above and below, from front and back, they must be studied till all novelty about them disappears. Several watches pass before a thorough mastery of their details can be had, and to attain this the keenest observation is needed. No scrutiny can be too minute, and nothing is too trifling to be noticed and reflected upon. When the engines are well understood, perhaps the most striking point of view is from near the thrust block. By looking forward between the columns all the principal moving parts may be seen in one small field of view. Close by, in rapid swing, is the low pressure connecting rod, with its crosshead above, darting along its well-oiled guides. Behind it may be seen the excentric rods crossing and recrossing each other in their erratic dance, with the curtseying quadrants above, while through their midst rushes the high pressure connecting rod, and crank brasses, intent only on their work. To the left are the circulating and air pumps, and the bilge and feed pumps, one behind the other, all driven from the low pressure crosshead by broad oscillating levers. To one really interested in the engines, as all good engineers are, these rushing, whirling masses of metal have a strange fascination, and force many curious thoughts on the solitary watcher, who now alone is responsible for the safe working of the engines.

Next to familiarity with the engines, the third must get a correct idea of his relative position on board. This will soon be learned. As a rule he will have to do the ordinary engineering work required on board, under supervision of the second, who also has the immediate control of the firemen, and is responsible to the chief for the correct carrying out of his instructions. The position of second is an arduous and responsible one. Every detail has to pass his inspection, and through him all orders pass to the third and to the firemen. The donkeyman, however, who goes on watch with the chief, and does all the work then required, is more directly under the control of the latter. With regard to the chief engineer, it will be found that the less he interferes with the work the more he will be respected, and the better will the work be done, if he has capable engineers under him. He compares notes with the second, consults him, and arranges with him what work is to be done when in port, or in reference to working of the men and engines at sea. His dealings should be entirely with the second, or the work will not be well done, and jealousy and bad feeling will soon appear. He may and must be firm, but the hand of iron should be as far as possible concealed under the velvet glove of courtesy. A bullying chief, or one who finds it necessary to display his authority, simply shows his weakness. He may be feared and disliked, but he cannot be respected. Whatever be the cause, whether imperfect education or roughness of up-bringing, it can hardly be denied that the self-assertive chief is too often to be met with, though there are many bright exceptions. As might be expected also, this unworthy kind of self-esteem is often in inverse ratio to a man's capabilities, or to his position, as for instance the most self opinionated men may be found among the more inefficient of the firemen, to whom orders must be given, but who must never be reasoned with. Among firemen, however, as among engineers, may be found many noteworthy exceptions.

All the parts of human mechanism on board bear a certain analogy to those of the engines. The chief engineer may be compared to the steam which drives all, but which is most effective when least seen and heard. The second is like the main driving parts of the engine, the third like the main parts driven, while the firemen in their varying degrees of excellence form the rest of the mechanism. Only when each part is in its proper place, and fulfilling its proper function, can there be peace among engines or men, so that the full effective power of each can be developed.

Thus we find that one of the first duties of a third is to understand not only the inter-relations of the various parts of the engines, but also his own relative position in the higher human mechanism of which he forms an important part.

The Suez Canal.—The receipts of the Suez Canal Company for the whole of January amounted to £204,000, and showed an increase of £21,200 against the January receipts last year.

THE DUDLEY BOILER EXPLOSION—III.

(Concluded from page 56.)

Mr. David G. Watson, who made the preliminary inquiry with regard to the explosion on behalf of the Board of Trade, read the report which he had prepared. In his opinion the explosion occurred when the steam was at or about the usual working pressure, and was due to the weakness of the plate at one of the vertical seams in the lower belt of plating in the cylindrical part of the shell, two plates, one on each side of the vertical rent, being blown out. The vertical seam that first gave way was flawed between the rivet holes. These flaws had the appearance of being of long standing, but were in the heart of the joint, and thus hidden from view. They started from the inner face of the outside overlap, and in several places were within $\frac{1}{16}$in. of being through. The two plates that were blown out formed part of the original structure, and were reduced in thickness from $\frac{7}{16}$in. to $\frac{5}{16}$in. by external corrosion, the rivet heads being also much reduced from the same cause. This corrosion, however, though serious, did not necessarily render the boiler unsafe, as the nominal stress on the metal between the rivet holes, with a pressure of 30lb., would only be about 9,100lb., which would not be sufficient to produce rupture if the material were sound and of good quality. In addition to the flaw at the vertical seam which first gave way, there were other similar defects that were not even suspected, and which of themselves were sufficient to have rendered the boiler unfit for use. At one of these cracks, which was 8in. in length, and penetrated right through the plate, there was positive evidence that leakage had occurred. Referring to the suggestion that the explosion was due to the pressure having become very much in excess of the ordinary working load, he said he had carefully examined all the evidence bearing on the point, but there was nothing to show that the ordinary working load of 30lb. was exceeded. The face of the safety valve was in a bad condition, and would not be steam-tight, but there was nothing that was likely to cause the valve to stick in its seat. He thought each boiler should have had its own independent pressure gauge, and that they were not equipped in this way was, he considered, a serious omission. The practice of having rods hanging from each end of the safety valve lever was, he also considered, a reprehensible one, although it was common in the district. The plate which gave way appeared to be of a brittle quality, as it broke when he attempted to straighten it with a wooden mallet for the purpose of cutting out test strips, while the tests themselves were of so unsatisfactory a character that they were not proceeded with. Alluding to the age of the boiler, he thought age of itself was no reason why a boiler should be condemned, but looking at the extensive repairs it had received at various times, he considered it would only have been a matter of prudence to have tested it with hydraulic pressure, and was of opinion that the application of such a test would in all probability have resulted in the discovery of the defects to which he had referred, and thus have prevented the explosion.

Examined by Mr. Smith, he said the boiler appeared to have been fairly well made in the first instance, but he did not consider South Staffordshire plates were of sufficiently good quality for a boiler of this description. The repairs which had been done to the boiler had been effected in a very rough manner, and the overlaps in many places had been heavily caulked.

Mr. William H. Fowler, assistant to the chief engineer of the Manchester Steam Users' Association, said he examined the boiler after the explosion, and prepared a report, which was handed in and read. He substantially confirmed the conclusions of Mr. Watson with regard to the cause of the explosion. He said, looking at the age and mode of construction of the boiler, as well as at the brittle character of the material, the wasted condition of the plates, and the existence of the old flaw, he did not think it necessary, in order to account for the explosion, to assume that the ordinary working pressure of 30lb. was exceeded. In his opinion, the boiler was in such a defective condition that its failure, even with a lower pressure than 30lb., could only have been a question of time.

Examined by Mr. Smith, witness said he considered the explosion was due entirely to the defective condition of the boiler, but he did not think the flaw at the vertical seam, where the boiler first gave way, could have been discovered by inspection, as it was out of sight. The safety valve, he thought, must have leaked badly, but he had no reason to believe it was inoperative. With regard to the removal of brickwork to admit of complete inspection, witness said he would not like to lay down a hard and fast rule. It was certainly desirable to remove it at intervals.

The interval, he thought, should not exceed six years, and should be less if there was anything to excite suspicion.

This having completed the evidence, Mr. Howard Smith summed up the case, calling the attention of the Commissioners to what he considered the leading points in the inquiry.

In reply, Mr. Mansel Jones, the presiding Commissioner, said he and his colleagues were very pleased with the way in which the inquiry had been conducted, and were obliged to Mr. Smith for the suggestions he had thrown out, which would receive full consideration in drawing up their report to the Board of Trade.

The inquiry then terminated, and in due course the report of the Commissioners will be issued to the public.

CORRESPONDENCE.

We do not hold ourselves responsible for the opinions of our Correspondents.

FENDER'S PATENT ENDLESS RAILWAY.

To the Editor of "The Practical Engineer."

Sir,—I called the attention of the Committee of the Lifeboat Institution to Fender's patent railway before it was exhibited in this country. I don't know what they did in the matter.—I am, Sir, yours, etc., J. W.

Sizewell, 6th Feb., 1888.

BOILER SETTING.

To the Editor of "The Practical Engineer."

Sir,—The very strong and apparently insurmountable objection held by many people concerned to setting boilers on narrow seatings, as advocated in your article of last week, and by all experts in boiler matters, would appear to be founded on the assumption that a large width of bearing is necessary to enable the bricks or seating blocks to carry the weight of the boiler safely. It would, perhaps, tend to remove this objection if some information were given as to the strength of firebrick to resist crushing, the safe weight that may be put upon it, and the approximate weight per square foot of bearing likely to result from the reduced width of seatings. Some information might also be given as to the durability of such seatings, and how long they may be expected to withstand the weight and temperature to which they are subjected. I have known a boiler 8ft. diameter set on fireclay blocks having only 2in. width of bearing. These seatings stood for many years, and for anything I know may be still standing satisfactorily. It would, however, be interesting to know if such a very narrow seating is advisable.—Yours, etc.,

February 6th, 1888. Argus.

POLLITT AND WIGZELL'S ENGINES.

To the Editor of "The Practical Engineer."

Sir,—Inclosed are a set of diagrams taken from one of Pollitt and Wigzell's engines. I have often heard it said that it is not possible to get anything like boiler pressure on their engines on account of the low pressure piston rod passing through the port holes of the high pressure cylinder. I think you will see by the diagrams that this is possible. In this case the boilers are 54 yards away from the engine. Boiler pressure 68lb., high pressure cylinder 15in. diameter, low pressure cylinder 27in. diameter, stroke 4ft. 6in., revolutions 88 per minute, temperature of water before going to engine 42 deg., after leaving 120 deg., vacuum per gauge 26in.—Yours, etc., J. W. J.

Wakefield, Feb. 6th, 1888.

[The diagrams forwarded by our correspondent are excellent examples from this class of engine, and we doubt if they could be improved except by equalizing the load on the two cylinders. At present the small cylinder is doing fully two-thirds of the work. The initial pressures on the small cylinder are 62lb. at one end, and 63½lb. at the other, or within 4½lb. and 6lb. respectively of the boiler pressure which is good considering the great distance the steam has to travel. We fail to see how the fact of the low pressure piston rod passing through the high pressure port can have any influence on the pressure obtained in the cylinder, providing the port is of ample size.—Ed., *P.E.*]

Proposed New College Building.—It has been decided to raise a fund of about £35,000 in order to erect a new building for University College, Liverpool, in that city, one of the colleges included in the Victoria University. A number of donations of £1,000 are already reported.

QUERIES AND REPLIES.

Strength of Lap Joint.—In a single-riveted lap joint exposed to tension, determine the diameter and pitch of the rivets in terms of the thickness of plate, and the three stresses f_t, f_s and f_b,

Where f_t = intensity of stress on material of plate.

" f_s = " " " rivet.

" f_b = " bearing pressure,

estimated on a diametral section of rivet. Find the diameter and pitch for ½in. plates when $f_t = 30$, $f_s = 22$, and $f_b = 42$ tons per square inch, and estimate the efficiency of the joint.—H.T.

Answer.—I do not comprehend what "H.T." means by the three stresses $f_t f_s$ and f_b, inasmuch as the 30 and 42 tons per square inch, as named by him, are much beyond the powers of resistance of wrought iron, as applied in construction to either a force of compression or extension. We will, however, assume t = thickness of plates; p = pitch or distance between rivet centres; d = diameter of rivets; c = breaking strain per square inch of section of plate in lbs.: s = shearing resistance per sq. in. of section of rivets in lbs. Then $(p-d)\,t\,c = {\cdot}7854\,d^2\,s$, when the joint is the strongest possible, and $p = \frac{{\cdot}7854\,d^2\,s + t\,d\,c}{t\,c}$. And the ratio of strength of riveted joint to that of the solid plate is

$$\frac{p-d}{p} = \frac{\frac{{\cdot}7854\,d^2\,s}{t\,c}}{\frac{{\cdot}7854\,d^2\,s + t\,d\,c}{t\,c}} = \frac{1}{1 + \frac{t\,c}{{\cdot}7854\,d\,s}}$$

and $t = \frac{{\cdot}7854\,d^3\,s}{(p-d)\,c}$. The values of c and s can be obtained by experiment only; while of the other three factors, the value of any two may be arbitrarily fixed, and that of the other determined therefrom by the above formula. If, for simplicity, we suppose $c = s$, which, when the plates and rivets are of the same material may possibly be the case, and $t = \frac{1}{2}$in., and $d = {\cdot}81$in.

$$\text{Then } p = \frac{{\cdot}7854 \times {\cdot}81^2 + \frac{1}{2} \times {\cdot}81}{\frac{1}{2}} = 1{\cdot}84.$$

And ratio of strength of riveted joint to that of solid plate =

$$\frac{p-d}{p} = \frac{1{\cdot}84 - {\cdot}81}{1{\cdot}84} = \frac{1{\cdot}03}{1{\cdot}84} = {\cdot}56 \text{ to 1, or 56 per cent.}$$

And again, if instead of iron rivets being used to the iron plates, we substitute steel rivets, having a greater shearing resistance of 25 per cent. more than that of the iron ones, then the ratio of c to s will be as 4 to 5. Suppose $t = \frac{1}{2}$, and $d = {\cdot}81$ as before

$$\text{then } p = \frac{{\cdot}7854 \times {\cdot}81^2 \times 5 + \frac{1}{2} \times {\cdot}81 \times 4}{\frac{1}{2} \times 4} = 2{\cdot}098$$

And the ratio of strength of riveted joint to that of the solid plate in this case is $\frac{p-d}{p} = \frac{2{\cdot}098 - 81}{2{\cdot}098} = {\cdot}614$ to 1, or 61·4 per cent.—W.A.

Chrome Iron.—I should be obliged for the name of any firm who manufacture chrome iron. I want a quantity of castings containing 15 per cent. of chromium.—Anxious to Trade.

Wöhler's Experiments.—I should like a formula which will represent the results of Wöhler's experiments on the repetitions of loads. Compare the diameters of the shafts of two engines, the power transmitted and revolutions of each being the same; in one the twisting moment fluctuates between 1¼ and ¾ the mean, and on the other between twice and ½ the mean.—H.T.

Marine Engines.—Why does the centre line of engines not always coincide with fore and aft centre-line of vessel, as in the case of the *Ormuz*. I presume that it is not the screw shaft that is out of line, but that the engines are inclined a little from the vertical?—Shiny Boots.

Locomotive Tank Engines.—What are the tanks of these engines cleaned with, and, why do they prime so furiously on the day after such cleaning?—Shiny Boots.

Load on Safety Valve.—Will "T.W." Blackburn, or some other correspondent please say to what pressure the escape valve on pump and safety valve on economiser should be loaded for a pressure in boiler of 100lb.?—T.H.

Steel Castings.—Would any of your readers give me any information as to the theory of moulding and casting the above? Also if there is any work published on the subject?—Moulder.

Marine Problems.—An engineer once stated that the secret of his success in consumption of coal was owing to the arrangement of his feed pump, part of the water at each stroke being returned to the hotwell. Would this effect any saving of heat, even if successfully carried out, or would the water really remain longer in the hotwell in consequence, though at first sight this would seem to be self-evident?—Q.

Colliery Pumping Engines.—Can any of your readers give me the particulars of a pumping engine at Snibston Colliery, in Lancashire; I believe the pump has a 26in. plunger. What was the depth of the mine, and the size of the engines, and has any description or illustration been published in any book?—W.M.

Tappet Motion.—Could any correspondent explain with a sketch the action of the tappet or plug rod in operating the valves of a Watt's single-acting engine (1769), and his double-acting engine (1784), through the intermediate mechanism, levers, &c.—A.G.K.

TO CORRESPONDENTS.

C.R.—The promised reply has had to be postponed owing to pressure of work, but it shall receive early attention. The second article you are looking for appears this week.

Alpha.—Hamblin Smith's Algebra, 3s. 6d., and Euclid, 4s. 0d., will serve you for one winter, after which you may tackle trigonometry and higher geometry. Goodeve's ' Elements of Mechanism," and " Principles of Mechanics," each 3s. 6d., are useful books. We have not published any work as yet, but can obtain for you any book you require.

Constant Reader.—We do not see what you have to complain about in the diagrams forwarded for inspection; they are very good ones indeed, and at the most could only be improved a very trifling amount. The high and low pressure diagrams follow each other very closely, and you get within about 4lbs. of boiler pressure. Certainly the initial pressure is not maintained as well as we sometimes see it, but the slight fall is no doubt due to the smallness of the steam ports. and cannot be affected by altering the valve. The vacuum is good, but is not obtained immediately on the commencement of the return stroke. a trifle earlier opening of the exhaust port would improve this a little.

Anxious to Know.—The valves of both cylinders steam very late at one end, as is shown by the sloping admission line . which ought to be straight up. This of itself will almost, if not entirely, account for the small diagram obtained from that end of the cylinder. You should first move the valve along the spindle so as to equalize the port opening at the two ends of the stroke, and, then take fresh diagrams: possibly you will find the steaming is then a little late at both ends, owing to the eccentric not being forward enough. See that the pipes to the indicator are quite clear and of ample size; sometimes these are choked, and a false diagram is obtained as we shall shortly show in an article on this subject. Your engine is very lightly loaded, but with the exception of the fault pointed out above the figures are good ones.

C.J.—The result is worked out by means of a simple proposition in Euclid. The limit of the movement, both up and down, is reached when the crank and the arm are at right angles, and as one-fourth of the time only is occupied in making the up stroke. the angle turned through by the crank in that time will be 90° or 45° on each side the line of centres. Therefore, the distance between the centres is the hypotenuse of a right angled isosceles triangle, the two equal sides of which are 6in. each, and hence is 8·485in. For the second part of the question we know that the resolved motion of the crank pin perpendicular to the arm is got by multiplying by the cos. of the angle between crank and arm, and hence the ratio of the angular velocities at any point is equal to $\frac{6}{x}$ cos. θ. where x is the length of arm at that point, and θ is the angle between crank and arm.

MAGNESIA AS A NON-CONDUCTOR FOR STEAM PIPES.

A new material is being extensively used in America for protection of steam pipes, and consists merely of a mixture of carbonate of magnesia mixed with 7 to 8 per cent. of asbestos to bind it together, for a purpose similar to the hair in plastering. This material is moulded by pressure to the forms running half way around the pipe, and a pair of such moulds is covered with cloth, which is continuous upon one side, serving as a hinge; in this manner it is placed round the steam pipe and secured by hoops. For special places, such as elbows, valves, and other irregular forms of pipe fittings, it is moulded in appropriate shapes. It can thus be placed upon the pipes and removed at any time without damage or deterioration. It is entirely inorganic, being neither changeable nor combustible, except the slight calcining of the magnesia by the carbonic dioxide in the air to which it might be exposed, but which does not affect its non-conducting property. The value of a non-conductor is due to the confined interstices within the material; and measurement has resulted in determining the fact that 6 to 8 per cent. is solid matter, the rest being the small air spaces existing throughout the mass.—*Engineering*.

MISCELLANEA.

Re-starting of Ironworks.—The Bromford Ironworks, West Bromwich, which have been idle since the failure of Messrs. John Dawes and Sons, are to be re-started. The works are one of the most extensive in Staffordshire, and consist of 68 puddling furnaces and seven mills. The new proprietors will trade as the Bromford Iron Company. One hundred hands will first be set on, and afterwards 250 more.

The Owen's College Engineering Society.—At a meeting of this society held on Tuesday evening two very interesting papers were read, the first by Mr. E. G. Hiller on "Stationary Engines at the Manchester Exhibition," and the second by Mr. E. Worthington, on "Locomotives at the Exhibition." The salient features of each class of engine were well described, and both essayists were very successful in fixing on the faults as well as the virtues of the various designs. Messrs. Adamson's and Hick Hargreaves' engines were commended for design, and the latter especially was praised for its beautiful workmanship.

The Chicago Bridges.—A force of men is being got together to critically inspect all the bridges and viaducts of Chicago. The impression is that many of them are in a very bad condition.

Important to Patentees.—The notices hitherto sent by the patent office to applicants for patents, reminding them of the date for filing a complete specification, will not in future be issued.

Bengal Railways.—It is reported that the Messrs. Rothschild are negotiating for the complete purchase of some of the Northern Bengal railways, especially those connecting Calcutta with the hills.

Salt Water in Towns.—A very strong argument against the introduction of a salt water supply for fires, etc., in New York, is found in the statement that a year's consumption for fire purposes is less than an ordinary half-day's consumption.

H.M.S. "Buzzard."—The examination of the port engine of Her Majesty's sloop Buzzard, which recently broke down has resulted in the discovery of a screw driver in the cylinder. The Admiralty have ordered an investigation to be made.

The Panama Canal—The directors of the Panama Canal Company will issue immediately an extraordinary number of their *Bulletin*, specially devoted to an account of the present position of the works. Evidence will be given that, far from the work having been suspended, important progress is now being made.

Electric Light at Southport.—The electric light is to be established in Southport. The Maxim-Weston Company, of which Mr. H. Hodge is the local agent, intends to set up in the town a dynamo, and anyone who wants an electric lamp put up on his premises can have it at the charge of one penny per hour's use of the light.

New Isle of Man Steam Navigation Company.—An order has been made for the winding up of this company, which our readers will remember owns the Lancashire Witch, and has only been in existence one year. The order will be postponed for a fortnight to enable the company to pay off the petitioning creditor, who is the owner of a dishonoured bill for £320.

A Successful Steel Manufacturer.—The will of Mr. Thomas Jessop, who died in November last, has just been proved. The deceased was the head of William Jessop and Sons, steel manufacturers, before its conversion into a limited company. The gross value of the personal estate in England is sworn at £656,449. The value of the personality in America has not yet been ascertained.

Steel Wire.—Four qualities of steel are used for wire rope making, viz.:—Extra strong plough steel, breaking strength 110 to 115 tons; mild plough steel, breaking strength 95 to 100 tons; best patent steel, breaking strength 80 to 85 tons; and Bessemer steel, breaking strength 40 to 45 tons. The maximum load, including the weight of the rope itself when used for winding, should not exceed one-tenth of the breaking load.

Hard Brass Castings.—The *Indian Engineer* says that two per cent. by weight of finely pounded bottle glass, placed at the bottom of the crucible in which red brass is being melted for castings, gives great hardness, and at the same time ductility to the metal. Porous castings are said to be almost an impossibility when this is done, and the product is likely to be of great service in parts of machinery subject to strain. An addition of one per cent. of oxide of manganese facilitates working in the lathe and elsewhere where great hardness might be an objection.

Institution of Mechanical Engineers.—The 41st annual meeting of this institution was held last week. There were 1,741 names on the books of the institution, or an increase of 67 over the previous year. Among the members removed by death were Mr. William Denny (Dumbarton), and Sir Joseph Whitworth. The chairman said that during the past year several of their members had had honours conferred upon them. Their research committees had under consideration the subjects of friction, riveted joints, a standard system of marine engine trials, and the value of the steam jacket. These research committees were doing an important work for the country, and they were being well supported by the members in this matter.

Technical Education.—The Carpenters' Company and the Joiners' Company propose jointly to hold an exhibition of models, drawings, and specimens of works in wood, within the respective trades designated by their titles, at Carpenters' Hall, in May and June next. The first division consists of constructive carpentry, in which skill in obtaining the greatest amount of strength at the smallest expenditure of material and labour is the object aimed at. The various classes include roofs, bridges, floors, beams, centring, scaffolding, etc. The second division is that of ornamental and constructive carpentry, in which architectural or picturesque effect, combined with strength and efficiency, is the aim. The other divisions are joinery and wood carving, all in hand work.

The Geological Society.—This society is likely to be broken up into two parties, owing to the new controversy over the evolution hypothesis which has been occasioned by the anti-Darwinian views expressed recently by Mr. Murray, of the Challenger.

Engineering Society, King's College, London. — On Tuesday, February 1st, the President in the chair. Mr. Metzgar read a paper on "Liquid Fuel." The advantages of liquid fuel for marine boilers are—(1.) It can be stowed away in any part of the vessel most convenient for ballast. (2.) The empty tanks can be filled with water, and so keep the vessel in her best trim. It gives off no smoke, and leaves no ashes. It can be lighted and extinguished as is required. The methods adopted for burning the oil are either to inject it into the furnace by means of a jet of steam which meeting the oil scatters it into a fine spray, sufficient air being admitted at the same time for its combustion ; or it is vaporised independently in separate generators, and thence conducted to the furnace, and burnt as a gas. The former is the method most usually adopted. In the pulveriser of Körting Bros., the oil is dropped through a narrow orifice across the path of a jet of steam and air, with which it mixes, and the mixture is emitted through a conical mouthpiece. In starting a boiler, steam must be raised either by means of coal, or by a small auxiliary boiler for working the injector. The latest form of injector is the Uiquhart, used on the Grozi-Isaritsin Railway, Russia. The author then pointed out the advantages of liquid fuel for armour-plate bending, and for melting scrap-iron. After a lengthy discussion in which Mr. Hewett, Mr. Jones, and Mr. Gask took part, Mr. Hewett mentioning that in war time ships could be loaded very much quicker with liquid fuel than with coal, the meeting adjourned.

Society of Engineers.—On Monday evening the first ordinary meeting in the present year of the Society of Engineers took place at the Westminster Town-hall. Professor Henry Robinson, the outgoing president, occupied the chair during the first part of the proceedings. and presented the premiums awarded for papers read during 1887. The Bessemer premium was given to Mr. Edmund Olander for his paper on "Bridge Floors" ; the president's premium to Mr. R. M. Bancroft for his paper on the "Renewal of King's-cross Roof" ; a society's premium was also presented to Mr. E. C. Thrupp for his paper on "A New Formula for the Flow of Water"; and one to Mr. R. J. Hutton, for his paper on the "Stability of Chimney-shafts." Professor Robinson then vacated the chair, which was taken by the president for the ensuing year, Mr. A. T. Walmisley, who proceeded to deliver his inaugural address, in the course of which he traced the gradual progress of the society from its initiation in 1854 up to the present time. The president discussed the causes which had led to the extended use of steel as a constructive material in the manufacture of bridges, roofs, and marine engines, as well as of steel chains. He drew a comparison between the size and weight of iron plates sold at minimum market prices 20 years ago, and the present increased size and weight, and expressed the opinion that, in face of the competition with steel, the limits in those respects at which iron plates could be economically produced had now been reached. Other points touched upon in the course of the address were water supply and drainage, and the effect of the transfer to municipal and local authorities of various undertakings which some years ago were executed by private enterprise.

Rock Boring and Tunnelling.—At a general meeting of the Engineering Society, King's College, London, on Tuesday, Jan. 30th, the president in the chair, Mr. Rundall read a paper on "Rock Boring and Tunnelling." Mr. Rundall began by giving a description of the method of boring shot holes in rocks for blasting purposes. The ordinary method of boring is to chip a hole by means of a chisel, or "jumper," and hammer worked by hand, the "jumper" being turned round a few degrees between each blow, and so a hole is gradually made. The introduction of machinery for rock boring has made much advance. The Burleigh rock drill, and the Darlington drill. were then described. The Burleigh drill consists of a piston and rod, to which the tool is fixed, working in a cylinder. The piston is made to reciprocate backwards and fowards by means of compressed air, admitted by an ordinary slide valve, which is worked by a tappet from the piston rod. The Darlington drill has a different mode of admitting the compressed air, which does away with all valve gear, the only working parts being the piston and piston rod. The author then described the diamond drill. This consists of a steel tube, at the end of which are securely fixed the diamonds or carbonates; the tube is rotated and cuts out a cylindrical block of rock. The author then went on to the subject of tunnelling through rock. Selecting the Mont Cenis tunnel as an example of one of the large tunnels that have been bored through the solid rock, he proceeded to describe the mode of construction. This tunnel is 7½ miles in length, and was commenced in 1858, and completed in 1871. The shot holes were bored by machine drills worked by compressed air, the air after leaving the drills serving the double purpose of ventilation and of cooling the tunnel. In the discussion which followed, Mr. Sparks, Mr. Frere, Mr. Jones and Mr. Gask spoke. A vote of thanks was given to Mr. Rundall, and the meeting adjourned.

Sheep-shearing by Machinery.—At the Adelaide Exhibition recently, a competition was held between the Wolseley shearing machine and ordinary sheep-shearers. The first trial was upon merino wethers, the ordinary shears being handled by a skilled shearer. The machine occupied six minutes 45 seconds, and the shears seven minutes 15 seconds, in taking off the fleeces. The judges having found that the shcarer's work was good average work, the machine went over his work again with the result that a further 7¼oz. of wool was obtained. The next trial was upon two merino lambs, the machine taking 6¾ minutes, the shearer 7¼, and again the machine took 7¾oz. of wool from the lamb after the shearer had done with it It was considered by those present that machine shearing is even more advantageous as applied to lambs than to grown sheep because it clips the wool in its full length, which often doubles or trebles its value. The machine also removes the wool in a fleece instead of chopping it into small pieces like the shears. Several persons who had never handled the machine before succeeded in the first attempt to shear with it.

SELECTED PATENTS.

APPLICATIONS FOR LETTERS PATENTS.

January 27th.

1233 Supplying Moisture Air to Weaving Sheds, J. Longworth, jun., Manchester.
1236 Feed - motion for Wood Planing Machines, T. N. Robinson, Manchester.
1237 Manufacture of Hammers, A. Jenkinson and T. Greaves, Sheffield.
1239 Railway Chairs, H. Biggin, Sheffield.
1240 Waggon Couplings, T. Holt, Liverpool,
1246 Pitch Chains, H. Vering, London.
1247 Type-writers, S. J. Sewell. London.
1250 Water Wheel. M. Immisch, London
1252 Pipe Facing Tool, T. Wood, Manchester.
1259 Heating by Steam, J. J. Royle, London.
1264 Heating Railway Cars. J. Shackleton, London.
1266 Braking and Starting Tramway Cars, J. Monteith, Glasgow.
1273 Drilling Appliances, A. Morisseau, London.
1274 Relieving Gas Retorts from Pressure, T. Settle, Westminster.

January 28th.

1292 Slip Hook, A. Wilson and N. W. Chittenden, London.
1293 Hydrostatic Motors, J. A. Rowe, North Shields.
1310 Draw-bar Hook, W. A. H. Hosken, Birmingham.
1313 Taps, W. Redfern, Manchester.
1324 Fluid Pressure Engines, B. Donkin, Bermondsey.
1329 Steam Boilers, O. H. Gentry, London.
1331 Vertical Boilers. H. Thompson, London,
1332 Portable Steam Cranes, G. M. Donkin, London.
1333 Chain Elevators, O. W. Gauhe, Liverpool.
1335 Pumps, W. Royce, London.
1336 Starting Tramway Cars. O. Imray, London,
1340 Connecting the Ends of Bands, B. Willcox, Middlesex.
1343 Semaphore Signals, H. Skerrett, Birmingham. (V. Spicer and J. Schreuder, Pennsylvania.
1345 Spanners, G. Porter, London.
1347 Screw Nuts, H. H. Lake, London. (A. B. Ibbotson. of Ibbotson, Bros., and Co., Limited, Italy.)

January 30th.

1355 Feed Water Heater, R. Howarth, Wolverhampton.
1375 Hoists or Lifts, J. Archer and H, Faulder, Middlesex.
1378 Railway Signalling, W. Smith and J. P. O'Donnell. Surrey.
1379 Stopping and Breaking Machines, W. P. Thomson, Liverpool. (F. Deimel, Germany.)
1380 Miners' Lamps. J. Moss, Liverpool.
1381 Gas Engines, O. Blessing, London
1390 Distribution of Oil over Rough Water, O. Imray, London. (C. H. Stebbins, United States.)
1391 Rotary Engines, W. H. Wyke, London.
1297 Propellers, M. Immisch, London.

January 31st.

1402 Testing the Fairness of Crank Shafts, J. Paterson, London.
1415 Steam Engines, G. Richards, Broadheath.
1418 Gas Burners. C. H. Kreissig, O. Hartig and O. Seim, London.
1426 Steam Jet Pumps, C P. Madan, Manchester.
1428 Nuts, H. J. Allison, Middlesex. (S. S. Stout and H. G. Underwood. United States.)
1446 Centrifugal Pumps and Ventilators, L, Vojácek, London.
1447 Apparatus for Moulding Pulleys, H. T. Anthon (Anthon and Sons), Chancery Lane.
1454 Screw-tap or Tool for Cutting Screws, J. Y. Johnson, Middlesex.
1467 Making Seamless Tubes, C. A. Marshall, London.
1474 Interlocking Apparatus for Railway Points, J. Saxby, J. S Farmer, and H. Reid, London.
1475 Wire Ropes, T. C. Batchelor and A. Latch, London.
1478 Liquid Meters. J. J. Talor, London.

February 1st.

1485 Oil Lamp Burners, F. R. Baker. Birmingham.
1500 Miners' Safety Lamps, J. Pearson, London.
1501 Steam Generators. T. F. Morrin, London.
1512 Furnaces of Steam Generators, J. McLaren. London.
1530 Multiple Drills, J. P. Woodcock and A. E. W. Gwyn, London.

February 2nd,

1540 Ball Valves, H. F. Hill, and H. Hill, Nottingham
1555 Rotary Engines, A. F. G. Brown, Glasgow.
1564 Lock-nuts, E. Field. F, S. Morris, and H. W. Ibbotson, London,
1574 Steam Boiler Furnaces. G. M. Brand and J. Hill, Glasgow.
1580 Punching and Gouging Machines, I. L. Berridge, Middlesex.
1588 Engines, G. Wilson, London. (L. F. McNett, New York.)
1595 Plate Rolling Mills, C. Davy, London.

THE

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EDITORIAL NOTICES.

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Communications intended for insertion in the current week's issue should reach us not later than Tuesday Evening.

We cannot undertake to return rejected manuscripts or drawings unless accompanied by a stamped and directed envelope.

Contributors are requested to write on one side only of the paper. Sketches should be sent on separate sheets.

TO ADVERTISERS.

Advertisements intended for insertion in the current issue should reach us on Wednesday morning at the latest.

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NOTICE TO NEWSAGENTS AND SUBSCRIBERS.

Numerous complaints having been made to us by Subscribers of the difficulty they experience in obtaining copies of the *Practical Engineer* in certain districts, we have to state that the Journal can be obtained by any Newsagent through the ordinary Trade channels, and no difficulty should therefore exist in obtaining copies by order of any Newsagent.

For the information of the Trade, we may state that copies can be obtained from either of our Offices in London or Manchester, or from any of the following wholesale houses, who are also supplied with Contents Bills for the use of the Trade:—

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JOHN HEYWOOD, Deansgate, Manchester.
ABEL HEYWOOD & SON, Oldham Street, Manchester.
J. MENZIES & Co., Hanover Street, Edinburgh.
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W. LOVE, 236, Argyle Street, Glasgow.
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GEORGE BROMBY, 26, Charles Street, Hull.
EDWARD KING, 37, Greyfriars Lane, Coventry,
&c., &c., &c.

NOTICE.

BACK NUMBERS.—*As we have received several letters from correspondents who have found a difficulty in obtaining* BACK NUMBERS *of the* PRACTICAL ENGINEER, *we have to state that all the back numbers are still in print, and can be obtained from our office on receipt of stamps to cover cost and postage.* CASES *for* BINDING *the* PRACTICAL ENGINEER *can be obtained from the publishers, price 2s.,* POST FREE. VOLUME I., *bound in cloth, containing the numbers from March to December, 1887, can also be had, price 6s. 6d.,* CARRIAGE FREE.

LORD BRASSEY ON AUSTRALIA.

THE Royal Colonial Institute held a meeting on Tuesday night at the Hotel Metropole, London, at which Lord Dunraven presided, and Lord Brassey read a paper on "Recent Impressions in Australia." In the course of his paper, Lord Brassey dealt with the labour question in rural districts, and with industrial establishments in towns. His Lordship referred particularly to a visit paid to Messrs. Mort's engineering works, at which in busy times employment is given to 1,100 workmen, the wages ranging from 8s. to 14s. for a day of eight hours. We understand that in all industrial establishments in Sydney the wages are on an equally high scale. This will no doubt seem very tempting to the artizan in this country who is working for his 28s. to 35s. a week, but the gilt is taken off the remark by a subsequent statement of his Lordship to the effect that the streets are crowded with the unemployed, a large proportion of whom bear the marks of penury. As a temporary relief for the unemployed, the Government have taken on about 4,000 hands to work in the public park which is in course of formation. This work, however, cannot last very long, and, indeed, it would be impossible for the Colonial treasury to bear the burden of maintaining many workers in unremunerative employment for any length of time. Lord Brassey urges that in New South Wales, as elsewhere, the politicians have been tempted to encourage a false system which, while pleasing and gaining the support of the working class, has had the effect of accumulating a debt which amounted two years ago to thirty millions sterling. The opening up of new railways has been mainly responsible for this debt. We do not for a moment doubt that the increased facilities for inter-communication and transport on land will result in increased traffic ultimately, but the immediate effect is, of course, to throw a heavy burden on the exchequer. The new Government, under Sir Henry Parkes, seems to be discouraging loans, so that we may expect a curtailment of the progress in large works for the next few years.

The schools and other educational institutions are reported to be well fostered, and the study of applied science is encouraged by means of liberal grants. It is on account of the attractions in the way of primary and higher education offered by the large towns, coupled with the higher rate of wages, that people have a reluctance to spread themselves over the country. There is no doubt profitable employment in cultivating and opening out the resources of the land, and working men who have no chance of certain employment in England would probably be the gainer by emigration. It should be remarked that in the older colonies much of the land suitable for peasant proprietors is already taken, but in Western Australia and the interior the unoccupied land is practically illimitable. In tropical Australia the white man is handicapped with the climate, and finds it difficult to work in the open field in the middle of the day, and this is a fact that must be borne in mind when considering Australia as a field for British emigration. The address of Lord Brassey was instructive, and bore evidence of coming from a man who had well studied the labour question.

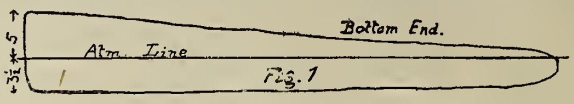
A NEW PRINCIPLE IN CLUTCHES.

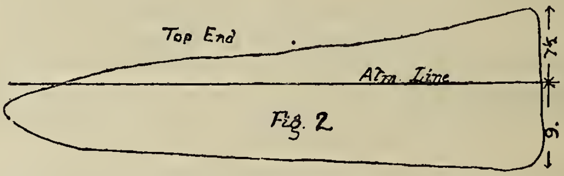
M. Raymond Snyers, of the Louvain University, Belgium, has invented a new mechanical combination, which seems to be exceedingly well adapted for application to clutch pulleys running at a high speed. Its advantages are, that it can be geared easily and instantaneously at any speed without causing a shock or damaging the apparatus, and it will remain in gear without any necessity for fastening the gearing rod; it may also be used as a dynamometer to check the power transmitted by a shaft. This apparatus consists of a driving disc, the face of which is studded with fine steel wires, much after the style of a wire brush. The disc to be driven has projections on its face to engage with the wires; it is placed opposite the brush, and is brought into contact with it by a sliding movement of the usual kind; very slight pressure only is needed. Each wire is, of course, bent a little by the pressure brought to bear on it, but in doing so it exerts a small turning effort on the disc—very small, something under an ounce. The thousands of wires in the disc, each providing its quota of turning effort, supplies the whole needful force for transmitting the power. A clutch erected in Brussels, 21¼in. diameter, running at 100 revolutions per minute, transmits 27 horse-power; and a Greenwich firm are using a 6in. clutch for transmitting motion from a shaft running at 80 revolutions, to an emery grinder making 3,500 revolutions. As the wire can only transmit the exact amount of force, corresponding to its deflection, necessary for it to pass the projections on the driven disc, it is seen that the apparatus can really be used as a dynamometer, and hence should be useful to those who let power. A very important advantage in this clutch is the fact that cumbersome and expensive gearing tackle is not required, and the fastest running machinery need not be stopped to put the apparatus in gear.

BAD VACUUM: ITS CAUSES AND CURE.

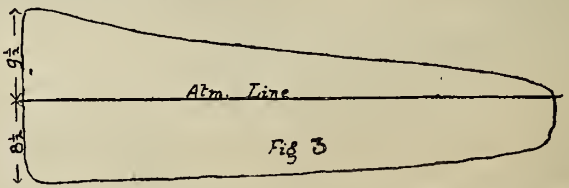
In our previous article on the "Money Value of Vacuum" we promised to revert to the subject, and in a subsequent article to point out some of the causes leading to the vacuum in the condensers and cylinders of condensing engines becoming impaired and destroyed. By far the most important of these is the admission of air either into the condenser itself or the condensing cylinder, or some pipe, etc., leading thereto. Sometimes one of the injection pipes may be a bad casting, or have a blown place in it, and if air can get into the pipe, even if only through a very small hole, it may be quite sufficient to seriously impair the vacuum. The first step, however, where it is necessary to improve the vacuum, is to ascertain whether it is defective in the condenser as well as in the cylinder, for it is no uncommon thing to have a good vacuum of nearly 13½ or 14lb. even in the condenser, and yet to be getting 8lb. or 9lb. only in the cylinder. This will be shown by the vacuum gauge where one is attached, but this gauge should be checked with the indicator applied to a tap connected with the condenser to see if correct, as they are not unfrequently inaccurate. Should the pressure, or using our familiar term "vacuum," shown in the condenser be found satisfactory, and be found defective in the cylinder only, as shown in our indicator diagram, we may at once look round for the cause of this in the engine room itself. It should, however, first be clearly ascertained whether the indication is a correct one, as it is quite possible our indicator card may be misleading, and we may vainly expend time and trouble in searching for the cause of a defect which does not exist.

A good illustration of this is shown in diagrams illustrated in figs. 1 and 2, which were sent to the writer some time ago, with others, from a number of old engines about to be overhauled. The diagram shown in fig. 1 is from the bottom end of the condensing cylinder of an old "McNaughted" beam engine, fig. 2 being the corresponding diagram from the top end of the same cylinder. The "vacuum," it will be observed, is not by any means what it ought to be in the top end of the cylinder, being only 9lb., and it ought to be improved some 3lb. or 3½lb., which in this case would mean a gain of about 36 indicated horse power. This, of course, it should be explained, is less the extra work put upon the air pump by the better vacuum obtained, which reduces to a slight extent the "money value" of the gain, as was pointed out by a correspondent replying to our article on the "Money Value of Vacuum," in *The Practical Engineer* for Jan. 20th.





In the diagram taken from the bottom end, however, the "vacuum" shown is only equal to 3½lb., or about 5½lb. less than shown in the top end diagram, and as the initial pressure on the piston is also considerably less, it was at once suspected that this diagram was not a true representation of the pressure in the cylinder. The surmise turned out on enquiry to be correct. The communication with the bottom end of the cylinder had been made through the cylinder bottom, and a connecting pipe had been carried to a convenient pipe outside the cylinder, and a tap fitted to this pipe for an attachment of the indicator. It proved on examination that this pipe had become partially choked up with dirt and grease, for which—the hole being placed in the bottom of the cylinder—it formed a convenient receptacle; and after the pipe had been removed and thoroughly cleaned out, fresh diagrams were taken, with the result shown in fig. 3.



Upon this latter figure it will be observed the "vacuum" appears very nearly as good as in the diagram from the top end of cylinder, and the initial pressure of steam at admission is about 2lbs. higher.

This example serves to illustrate the importance of being perfectly sure that the indicator cards are correct representations of the pressure in an engine cylinder at each point of the piston's stroke, before taking any important steps, or founding any judgment upon a diagram.

It not unfrequently happens, however, that in a pair of indicator diagrams the vacuum shown on the card from one end of the cylinder will be one or two pounds better than that shown on the diagram from the opposite end. In such cases it will generally be found that the end showing the worst vacuum is the one where there is a gland and stuffing box, through which, if not properly packed, air may be drawn into the cylinder. By screwing up the gland of the piston rod stuffing box, or re-packing it, an immediate improvement may often be made, and in horizontal engines, where the piston rod is carried through the back end of the cylinder, and a central slide fixed behind, it will very often be found that the vacuum shown on the back end card is not so good as on the card taken from the opposite end. This article, however, is already long enough, and the further consideration of the subject must be deferred to another week.

TRANSMISSION OF POWER.—III.

BELTS.—III.

The author of the paper further states that his experiments convince him that belts or ropes are commonly made twice or three times as strong as they should be, and are generally put on as much too tight, even to the extent of springing the shafts or causing breakages. His experiments included the transmission of 40, 80, 150, and 750 H.P. The tightness of the belt should be carefully adjusted by the help of a dynamometer, and not left to the judgment of the workman. The tension should be about 10 per cent. in excess of that determined by calculation, and in such case the whole gearing will last much longer, and heating, etc., of the journals will be prevented, and less driving power will be required. He states that in a case where belting was substituted for spur gearing the advantage was only three per cent. on a gross of 750 H.P.

General Morin gives the working tension of leather belts at 285lb. per square inch, one-third of that recommended by the author.

Mr. G. Schmidt, in an article on the "Theory of Transmission of Power by Belts," which appeared in *Dingler's Polytechnisches Journal*, states that in America Roper's empiric formula is used to determine the width of belts.

$$\text{Rule } B = \frac{2 \cdot 21\, P}{L}$$

where B is the width of the belt in inches, L the length of that portion of the smaller pulley with which the belt is in contact, also in inches, and P the force in lbs. acting at the circumference of the pulley. Professor Radinger has found that this formula may be used for forces varying from 100lb. to 850lb., and belts varying in width from 6in. to 18in. He also considers that by taking into consideration the pressure of the atmosphere upon the outer surface of the belt, in consequence of the partial vacuum between the belt and the pulley, the width may be reduced to that given by the formula—

$$B = \frac{1 \cdot 4\, P}{L}$$

The minimum pressure of the atmosphere on the belt is taken to be about 1·7lb. per square inch, and, to ensure safety against slipping, the length of contact between the belt and pulley is taken to be 1½ times as great as theory shows to be necessary. With a given force acting on a belt, the breadth is inversely proportional to the diameter of the pulley.

The above formulæ appear to give a strain on the belts of from 200lb. to 300lb. on the square inch, which is that commonly used in English practice.

FORMS OF TEETH FOR FRAME SAWS.

The following notes of experiments made at the works of Leistler Brothers, of Vienna, and recorded in the Foreign Abstracts of the Proceedings of the Institute of Civil Engineers, vol. 56, will be interesting to many of our readers:—

The saws were operated by vertical reciprocating mechanism of the ordinary character. The wooden frame carrying the blade was screwed to motion blocks travelling in guides, the blocks receiving their movement direct from the connecting rod, and the saw could thus be removed for sharpening without altering its tension.

Pine, oak, lime-tree, and mahogany were experimented upon. The saws had three different forms of teeth.

No. 1 saw had teeth set at right angles. The angle at the breast being 90°, at the point 42°, and at the back 48°, the breast perpendicular to the ground.

No. 2 had overhanging teeth, the angle at the breast being 74°, at the point 26°, and at the back 48°.

No. 3 had back-springing teeth, the angle at the breast being 106°, at the point 58°, and at the back 48° as before.

Forty-one experiments were made with No. 1, 25 with No. 2, and 26 with No. 3. The following is a summary of the results obtained—

1 The power required to move the carriage when empty was 1·6 H.P.; when carrying the log, 1·675 H.P.; when carrying the log against the saw, with pine, oak, or mahogany, 1·9 H.P.; the power required to move the carriage, carrying the log against the saw with lime-tree, was about 2·2 H.P. The greatest amount of work done was with pine, viz. 89 square feet per hour.

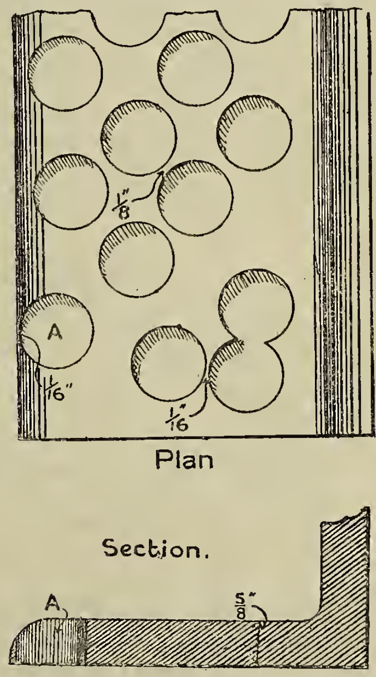
2 All the saws seemed to cut pine equally well, so that the shape of the teeth is of little importance.

3 For oak and mahogany No. 3 is most suitable, No. 2 next, and No. 1 worst.

4 For lime-tree No. 2 is much the best, No. 3 next, and No. 1 worst.

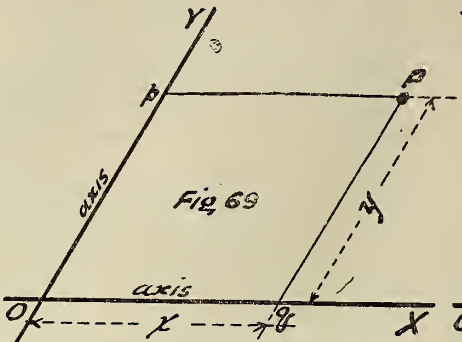
REMARKABLE SPECIMEN OF PUNCHED STEEL.

The illustration herewith is from the *Engineering News*, of America, and exhibits a piece of punched steel, the elastic limit of which is 32,300lb., and ultimate limit 57,800lb. Each of the holes is perfectly sharp and distinct, and the metal between shows no sign of having been injured or appreciably disturbed. The edges of the two holes which intersect each other, of the two only $\frac{1}{16}$in. apart and of the one only $\frac{1}{16}$in. from the edge (or beyond the point where the rounding of the edge begins) are especially remarkable. The thread of metal left in the latter case is to all appearance, says our exchange, as good and sound as any part of the bar, and shows a knife-edge at top and bottom. The appearance of the punched specimen seems to make it quite certain that the metal between the punch holes is far less injured than is ordinarily expected, even with the best materials.

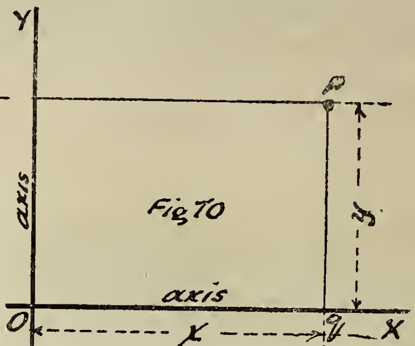


A LARGE PASSENGER LOCOMOTIVE.—An unusually large ten-wheel passenger engine, says the *Railroad Gazette*, is now being built in the Schenectady locomotive works for the Michigan Central. The drivers are 68in. diameter, and the cylinders are 19in. by 24in. The boiler, which is of Otis steel, is 58in. diameter, and has 147 two in. semi-steel flues. The fire-box is 8ft. long by 42⅞in. wide, and, like many recently built, is placed above the frames, which gives increased width. The tank is carried on two four-wheel channel iron trucks. The capacity of the tank is 3,800 gallons, and the tender has a capacity of eight tons of coal.

LESSONS IN MECHANICAL DRAWING.—XII.



Oblique Co-ordinates.

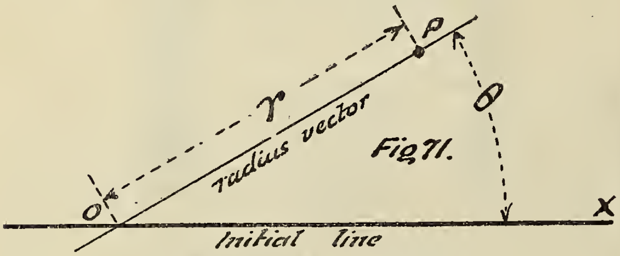


Rectangular Co-ordinates

LOCI.

To make the position of any point in space perfectly definite, we require to know its distances from three fixed planes of reference. On paper we require two fixed lines of reference; for if we consider the means of fixing the position of a point on paper, we shall find that we cannot do with less than two measurements, and that these two must be made in a particular way.

Suppose that we begin with one fixed point of reference. The distance of any other point from that may be given. But the one measurement would not fix its position, as that other point might occupy any position in the circumference of a circle, having the given distance as its radius, and the fixed point of reference as its centre. Next, the distances of any point from two fixed points of reference may be given. This would be ambiguous, as the point required might then occupy a position on either side of the line, joining the two fixed points. Similarly we might use three fixed points of reference, but that involves three measurements.



Polar Co-ordinates.

If now we take a point and a line for reference, we have the same ambiguity as when using two points. The circle round the fixed point cuts the parallel to the line in two places, except in one particular case, viz., when the distance given is exactly half the perpendicular from the fixed point to the fixed line.

If we next try two fixed lines of reference, we shall find that they will not answer the purpose when they are drawn parallel to each other, but that they will do so perfectly when they cross one another. They may cross at any angle, but are generally drawn at right angles as being more convenient. The two parallels drawn from any point to these lines of reference or "axes," will give its "co-ordinate distances" from them.

In fig. 69, O X and O Y are the axes set obliquely, and in fig. 70 they are shown set at right angles. P p and P q are the co-ordinate distances of a point P, more often referred to in geometry simply as x and y respectively.

Another equally simple way of fixing the position of a point is that by two measurements, one linear and one angular, shown in fig. 71. O is any fixed point, called the "pole," and O X a line of reference drawn through it, as "initial line." The line joining any point P, with the pole O, is its "radius vector," and the angle between it and the initial line is the "vectorial angle." The two measurements required are the length of the radius vector and the magnitude of the vectorial angle.

Having thus found a means of fixing the position of any point P, when two measurements are given, let us now consider the case when P is represented as a point moving in a certain path on the paper. This is a part of mechanical drawing of very great importance, as it forms the basis of all diagrammatic representations, when the product of two variable but mutually dependent quantities has to be represented.

When a sufficient number of the co-ordinate distances are either given or obtainable, we can then find as many points, representing successive positions of the moving point. These, when plotted on the paper and a fair curve drawn through them, give a more or less accurate representation of the path, according to the number of points taken.

The line or curve so found may represent:—

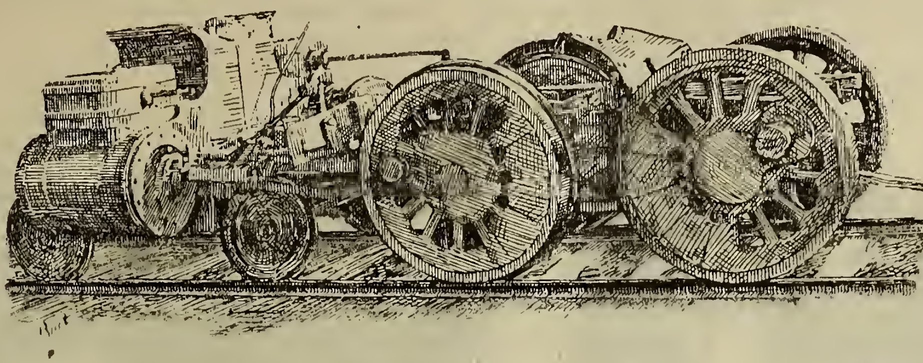
(1). The results of some experiment;
(2). Some physical law;
(3). Some geometrical curve or figure.

In (1) the data is supplied in the form of tabulated results. For example, in experiments on the strength of materials in testing machines, the two quantities of which we wish to know the relation throughout are the stress and the strain, or in other words the resistance of the test piece and the corresponding deformation which it suffers during the experiment. Observations are made as to the amount of the one, and measurements taken as to the extent of the other, which when represented to suitable scales, give us the series of co-ordinate distances necessary for drawing the curve, which will show the behaviour of the material under a constantly increasing load.

In (2) the data is generally presented in the form of an equation, which is the algebraic expression of the law, and the curve drawn is termed the "locus" of the equation, in which x and y stand for the co-ordinate distances as shown in figs. 69 and 70, or r and θ as in fig. 71. By assuming a series of values of x, for example, and finding the corresponding values of y, we can obtain as many co-ordinate distances as are necessary to draw the curve required.

The purpose may be (a) simply to illustrate some well known law, or (b) to help in the interpretation of some curve of results, as obtained by experiment; *e.g.*, (a) The relation between times and spaces in the case of a falling body is illustrated by a parabolic curve; (b) In indicator diagrams the pencil traces a line on the card, which shows the relation between pressures and volumes from point to point of the stroke, while a quantity of steam, air, or gas is operating on a piston in a cylinder. In such cases we often want to know the position of the theoretical curve which we draw, in order

A REMARKABLE LOCOMOTIVE BOILER EXPLOSION.



to compare it with the actual curve as obtained by the instrument.

In (3) the data is usually supplied in the ordinary way for constructions in geometrical exercises; but the connection between these geometric curves or figures may be made more apparent to the mind of the student by considering them also as "loci," or paths of points moving on the paper according to certain conditions. The conditions may be given in the equational form, with reference to the axes before referred to, but they may be expressed more simply as follows, beginning with those known as the conic sections.

(*a*) A straight line:—The path of a point which moves so that its distances from two fixed lines or axes are either always equal or in some fixed proportion to one another.

(*b*) A circle:—The path of a point which moves so as to be always at the same distance from some fixed point (its centre).

(*c*) A parabola	is the name given to the curve which shows the path of a point, according as its distance from a fixed point is always	equal to,	its distance from a fixed straight line
(*d*) An ellipse		less than, or	
(*e*) An hyperbola		greater than	

(*f*) A cycloid	is the name given to the curve which shows the path described by a point on the circumference of a circle, according as the circle rolls	on a straight line,
(*g*) An epicycloid		upon a circle or
(*h*) An hypocycloid		under a circle.

(*i*—*n*). Each of the figures *f*, *g*, and *h*, may be prolate or curtate, according as the describing point is within or without the rolling circle, and then the curves are called "trochoids."

(*o*) An involute:—The curve described by a point at the end of a string, while the string is being unwound from the surface of a cylinder (in a plane perpendicular to its axis).

(*p*) A spiral:—The path of a point which moves round a fixed point as centre, and at the same time moves from it.

In the next lesson we shall begin some drawing exercises on the various curves enumerated in this.

A REMARKABLE BOILER EXPLOSION.

A remarkable locomotive boiler explosion occurred on the Atlantic and Pacific Railroad on November 1. The accompanying illustration represents the locomotive, which was originally an eight-wheel consolidation, after the explosion. We are indebted to the *Engineering News* for the engraving.

The general nature of the explosion is clear. The front end of the engine and boiler was torn completely free from the cylinder castings (as shown in the first view), and thrown almost directly forward, a little to the right. The engineer's body was thrown far to the right, and the fireman's and brakeman's (who was riding on the engine) still farther to the left; but the fireman's watch, by some mysterious chance, was snatched from his pocket (or was perhaps in his hands), and was caught by some opposing force which threw it in the opposite direction from himself. The hands had stopped almost to a second at the moment noted on the telegraph line as the time when the wire was cut by the explosion.

The crown-sheet was thrown almost vertically upward (as is apparent from the small lateral distance it was thrown), but a little to the right. The wagon top of the boiler, and the air-pump, were thrown well forward, although placed toward the rear of the boiler. These facts all point to a rupture in the crown-sheet of an unusually serious character, a little to the left of the centre, which was instantly followed by a complete collapse. It would seem as if any ordinary breakage of stays or stay-bolts was insufficient to explain the great and *radial* violence, so to speak, of the explosion. In other words, the first impulse must have been down, or such impartiality in the lateral distribution of the fragments could not have resulted; for there can be no reasonable doubt that had not various rear parts of the locomotive been caught by the cars behind, and piled up in their wreck, they would have gone as far backward as other parts did forward and sidewise.

ECONOMY OF HEALTH IN WORKSHOPS.—II.

(*Concluded from page 53.*)

Having so far referred only to outlets depending on the heat of the room, or the wind for their action, I now turn to artificial means of ventilation. Heat is the most constantly available power, either by direct fire-heat, or by steam or hot water, but any such means are less positive and more costly than ventilation by power, applied to fans of one form or another. Heat can be applied by placing a fire or a few gas burners below an up-cast shaft, so as to make a high column of hot air, like that of a chimney. I need scarcely remind engineers that the heat should be applied at the bottom of the flue, and not at the top, as I have known architects and others to place it, under the idea that heat draws air to it. If flame is used thus, great care must be taken to have the flue fireproof, and so arranged that no harm would ensue if the dust in it caught fire. A much safer plan is to put a coil of steam or hot-water pipes below the up-cast flue, with a regulating valve, so that the most heat may be turned on in hot weather, and the least in cold weather.

The best of all known means for inducing and regulating the ventilation of workshops are fans driven by power. In most workshops the power can be given by shafting, or steam can be supplied to a little engine attached to the fan. In some cases it would pay well to apply a gas engine for the purpose; the power required is very small compared with the results attained. Thus one indicated horse-power will, under favourable conditions, drive 12,000 cubic feet of air per minute, or 720,000 cubic feet per hour, in and out of a workshop, equal to the draught of about 200 parlour chimneys, and affording the minimum ventilation required for 720 workmen. Even in mild weather, when tenfold ventilation is required, it would serve 72 men. With such a power at hand, there is now no excuse for ill-ventilated workshops, for all the risks of back-draught, and the irregularities and contrarieties of wind ventilation are overcome by the power fan, which will give as much or as little air as you require by the simple regulation of its speed. The fan should be fitted to the outlet, as it is difficult to disperse its violent draught when used on the inlets, and as only one outlet is best for each room, there is the one place for the fan. An outlet shaft, as already described, will be required, as the fan cannot advantageously discharge through a side opening, which may meet the pressure of strong winds at times. Sometimes, where dust has to be kept down, and has to be carried away from lathes, etc., it is convenient to use the space under a boarded ground floor, as the exhaust chamber leading to the fan. Each lathe, etc., having an exhaust pipe through

(*Continued on page 80.*)

TURTON'S IMPROVED PATENT RAILWAY SIDE BUFFER.

MANUFACTURED BY MR. GEORGE TURTON, THE PATENT BUFFER, STEEL, AND FILE WORKS, SHEFFIELD.

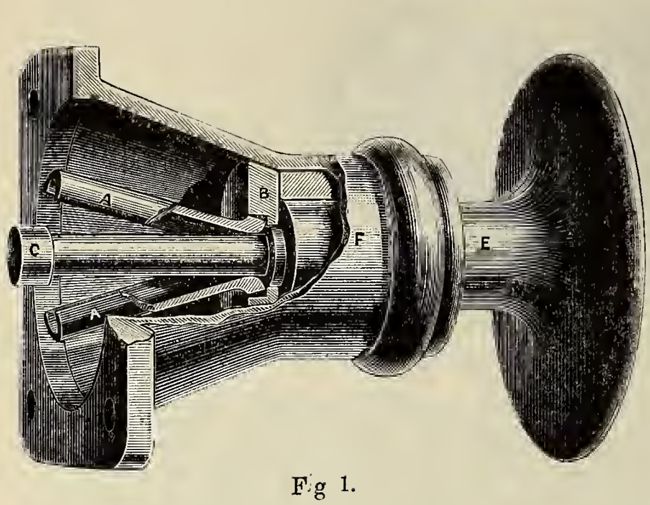


Fig 1.

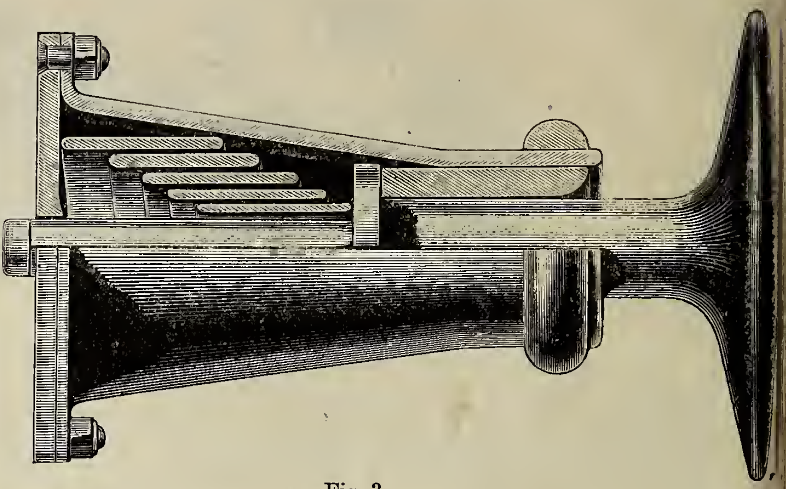


Fig. 3.

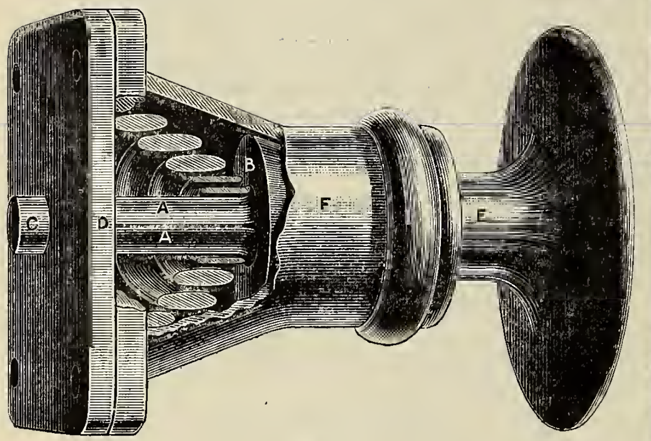


Fig. 2.

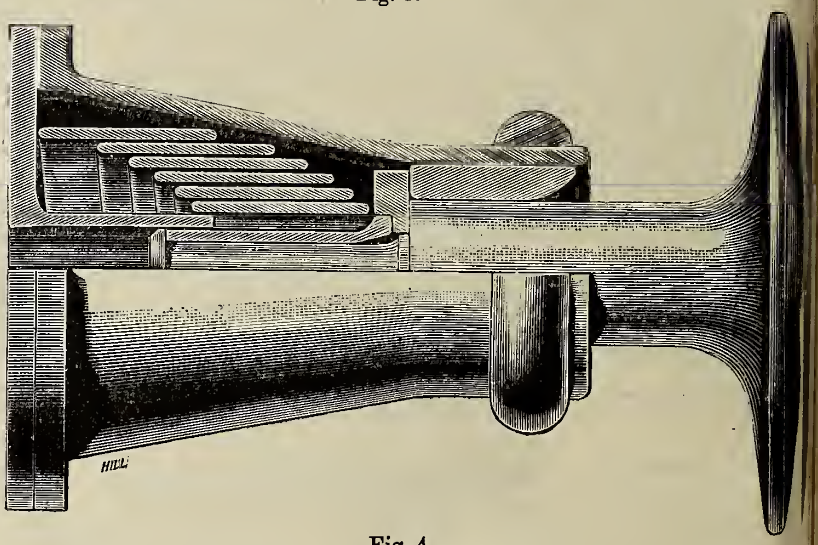


Fig. 4.

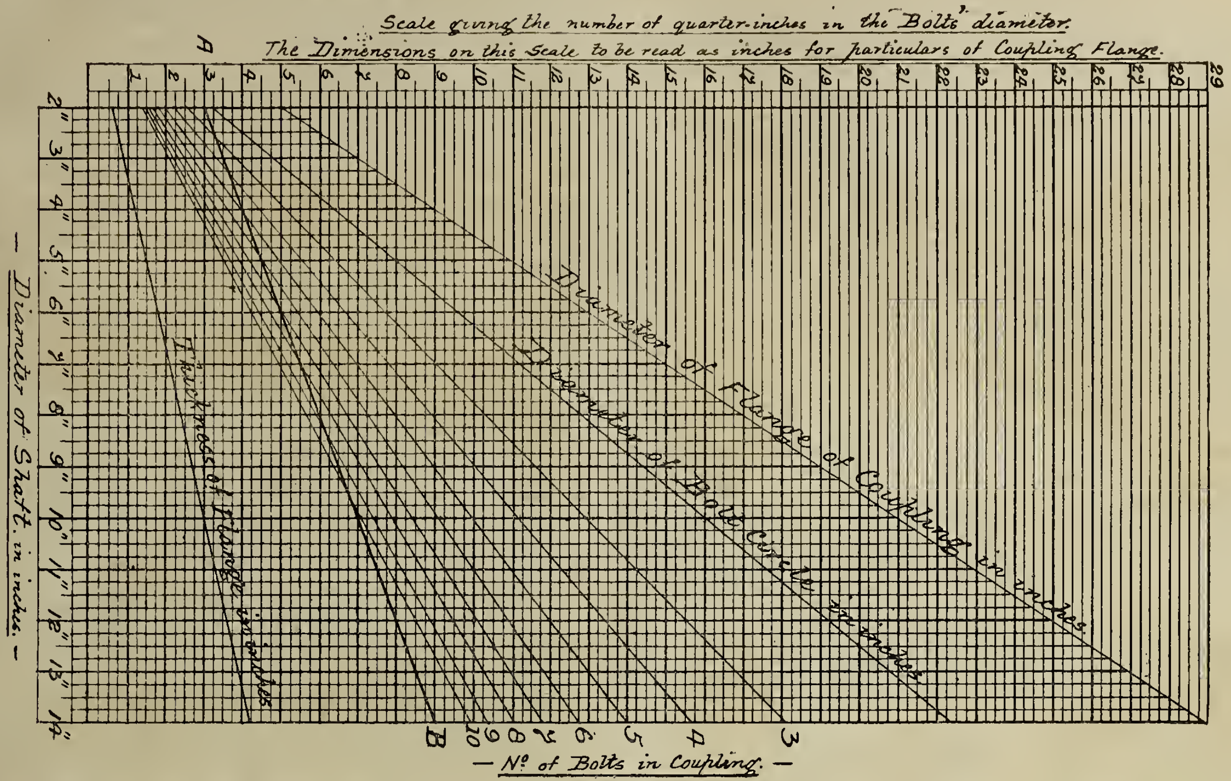
The above engravings represent a new form of railway buffer, recently introduced with great success by Mr. George Turton, of the Patent Buffer, Steel, and File Works, Sheffield, and which is manufactured solely by himself. In Turton's original patent buffer the plunger could not be withdrawn for repairs without injuring the case, and hence a serious objection was raised against it. The inventor, however, has now improved this buffer very considerably, and in its present form, illustrated above, the objection named has been successfully overcome. By simply removing the back plate D, the spring, half tubes A A, and washer B, and plunger E can be withdrawn as shown in fig. 1. When put together again the buffer is firm and compact, as shown in figs. 2 and 3; and there being no screws, cottars, etc., in it, nothing can possibly come loose. Further, should the spring at any time become injured, so as to lose its resisting property, the loose washer B cannot leave its proper position. No special tools are wanted for liberating the parts of this buffer; it can be done in any place or at any time by an ordinary spanner. A slightly altered form is illustrated in fig. 4, to be used in some cases for locomotives when it is desirable that the spindle shall not enter the buffer beam; the backplate in this case is fitted with a tube or sleeve into which the spindle slides. This buffer combines all the advantages of Mr. Turton's original patent with those mentioned above, and is rapidly coming into general use.

Engineering in China.—An item of news has just come from the far East which will interest commercial men and engineers. The Chinese Government have at length definitely agreed to dredge the Woosung bar at the mouth of the Yangtsze river. This task, when accomplished, will add largely to the importance of Shanghai and its accessibility by large steamers.

MANCHESTER ASSOCIATION OF ENGINEERS

The thirty-second anniversary dinner of the members of this association was held on Saturday at the Grand Hotel, Manchester, Mr. Samuel Dixon, the president, in the chair. The annual report of the council congratulated the members on the satisfactory position of the association, the increase in the number of members, and the successful progress made during the year. The total number of members was now 316, and the balance standing to the credit of the association amounted to £2,568.—Mr. E. Leader Williams proposed "Prosperity to the Association," and after remarking upon the generally satisfactory character of the report which had been read, said that on a previous occasion he had made a promise that he hoped some day to show the members over the works of the Manchester Ship Canal, and it would now give him the greatest pleasure to fulfil that promise. They would see the best development of steam excavators, as they were now produced, and the plant of this description on the length of the canal would be equivalent to the work of 10,000 men. Mr. Walker, the contractor, had put down a splendid plant of every description, and he was sure he would finish his work within the stipulated time.—The Chairman, in responding, dealt specially with the question of technical education. This was a matter which intimately concerned them as a body of engineers. Under the present system the training of youths in their trade was defective and haphazard. Hitherto there had been two distinct types of engineers—one the schoolmen, lacking workshop experience, and the other the practical men; and they had seen each type sin most grievously for want of the knowledge the other possessed. In the present day the tendency was in the direction of a fusion of these two types, and they as an association ought

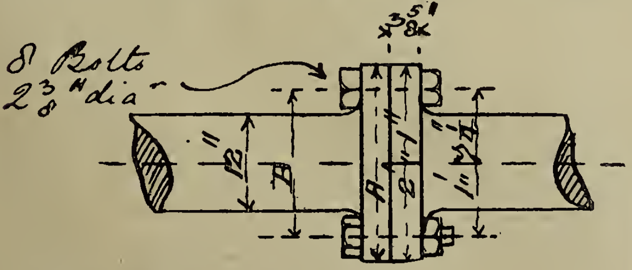
GRAPHIC DIAGRAM FOR SOLID FLANGE COUPLINGS.



to make their voice heard with the object of directing that portion of technical instruction which referred to the training of youths for engineering workshops. He would propose that their association take up the matter, and determine the chief branches of study youths should pursue in evening classes; and further, that the association should issue a short syllabus at a moderate price that might be a guide in the hands of every youth entering a workshop.—Mr. Thomas Ashbury proposed the health of Alderman W. H. Bailey, the guest of the evening, who had for the last three years occupied the post of president of that association. — Alderman Bailey, in responding, said he quite agreed with the sensible remarks which had fallen from the President on the question of technical education. The problem they had before them was to provide some efficient means whereby the practical training in the workshops could be followed up by scientific instruction in night schools, and that society ought to make itself felt by showing the sort of class book that would be the most useful to youths who were engaged in the engineering trades.—Other toasts followed.

GRAPHIC DIAGRAM FOR SOLID FLANGE COUPLINGS.

This diagram is extremely handy for finding at a glance the necessary dimensions for a flanged coupling, such as is used in marine engines most particularly, and in other types of engines in general, and in which the flange is made solid with the shaft, as in the sketch herewith.



The lines which require describing are :—

(1) For finding the diameter of flange of coupling, as at A. [NOTE.—Let us take for an example a 12in. shaft, we then obtain by the aid of the diagram 25in. as the diameter of flange.]

(2) For finding the diameter of bolt circle, B in sketch. This will give us for a 12in. shaft, 19¼ inches.

(3) The thickness of flange may now be read off, viz., 3⅝in.

(4) We now come to the question of the number of bolts which are necessary. This may be any number to suit the taste of the designer, but the line marked AB in the diagram gives a very good proportionate number for the various diameters of shafts. Thus for a 12in. shaft we obtain eight bolts as a result.

(5) With respect to the diameter of bolts required. The lines numbered from 3 to 10, on the right hand side of the diagram, give the diameter of bolts necessary for any number of bolts from 3 to 10, so that those using the diagram may not be restricted to the number obtained by line AB (provided they use the bolt circle diameter obtained by the diagram). Thus for a 12in. shaft with eight bolts, we find the result to be 9½ quarter inches, or 2⅜in. diameter. If 10 bolts were put in the shaft the bolts would require to be 8½ quarter inches, or 2⅛ inches diameter. [NOTE.—The diameter of bolts as found above, is such that the resistance they offer to shearing is exactly equal to the resistance of the shaft to torsion, the material in both cases being the same.]

The method of arriving at this result was given in *The Practical Engineer*, vol. I., pages 139 and 140.

We are now able to put the necessary dimensions on the sketch, viz :—

Diameter of shaft, 12in., flange, 25in.
Bolt circle, 19¼in., thickness of flange, 3⅝in.
No. of bolts, 8, diameter of bolts, 2⅜in.

If steel bolts are used in an iron shaft, the diameter of bolts may be reduced until their shearing strength is equal to that of the iron bolts, as found by the diagram.

Then if d_s = diameter of steel bolts required ;
" d_i = diam. of iron bolts found by the aid of the diagram
" f_i = shearing strength of iron ;
" f_s = " steel ;

$\frac{d_s^2}{d_i^2} = \frac{f_i}{f_s}$ (1) ; or, diameter of steel bolt, $d_s = \sqrt{\frac{d_i^2 f_i}{f_s}}$ (2) ; or

$d_s = d_i \sqrt{\frac{f_i}{f_s}}$ (3).

If f_i be taken as 18½ tons per square inch, and $f_s = 23$ tons per square inch, then $\sqrt{\frac{18\frac{1}{4}}{23}} = \cdot 9$ (nearly), so that the diameter of a steel bolt may be ·9 of that of an iron one.

FORCED DRAUGHT.

The following abstract of an article on the engrossing subject of forced draught which appeared in *The Engineer* will be read with interest.

Forced draught means neither more nor less than supplying the furnaces of a steam boiler with more air than the natural pull of a chimney will give. There are three distinct methods of obtaining the necessary air pressure, namely, fans either working in the stokehole or near it on deck, as in the case of the Irish mailboats fitted by Messrs. Laird, or at the base of the chimney, so as to draw air through the furnace instead of forcing it, jets in the chimney augmenting the draught, or some form of air injector, such as Körting's, which is used instead of a fan. It does not appear so far that any appliance answers as well as a fan, driven, of course, by a separate engine. The object had in view is to augment the quantity of steam which can be produced by a given weight of boiler. It is clear that, of two boilers, that which burns most coal in a given time ought to make most steam. There may be the further advantage that with forced draught combustion may be more perfect than it is with the natural draught, and that in this way a certain amount of economy may be obtained, which is, be it understood, quite a different thing from efficiency. It is also possible that the use of forced draught may be anything but economical. In torpedo boats, for example, worked with a reasonable draught, the boilers are very economical, but as soon as a heavy air pressure is established in the stokeholes, the economy falls off, because the smoke-box temperatures rise, and considerable quantities of fuel are ejected from the chimneys unburned. It must be always clearly kept in view that a forced draught system cannot be successful in merchant vessels if it entails a wasteful use of coal. But the tendency is always in that direction, and, besides, there is considerable risk that the furnaces will be ruined by the tremendous localised heat.

Apparently nothing can be more simple than to send in air to a furnace at a pressure of an inch or so of water. In reality the problem of doing this with success is excessively difficult of solution. Troubles arise on every hand to perplex and worry the engineer. One great difficulty lies in getting the air to diffuse itself properly through the fuel; another is to prevent the localisation of heat inside the furnace, and, we may add in the stokehole as well. Then fans give trouble, grate bars are burned, bridges give way, seams start leaking, and so on, until the shipowner gives up the whole scheme in disgust. In great measure all these troubles are the result of ignorance, and that ignorance is due to the circumstance that there is so little available experience. There is reason to believe, however, that plenty of information will ere long be put within reach. One of the most recent and most valuable contributions to the literature of the subject is a paper by Mr. William Geddes Spence, on "The Combustion of Coal and some Evaporative Experiments with Forced Draught," read before the North-East Coast Institution of Engineers and Shipbuilders, on the 11th of January, 1888. The whole paper is a useful treatise on combustion, but that portion which claims our attention at present deals with forced draught. Mr. Spence first carried out a series of experiments with natural draught, using, of course, north country coal, and arrived at the following conclusions :—"(1) That it is impossible to obtain satisfactory combustion in furnaces having the whole air supply drawn up from the ashpits through the fires only. (2) That with any arrangement of grate similar to that used in these experiments a collective area of not less than $\frac{1}{24}$ to $\frac{1}{20}$ of the open space between the fire bars should be allowed for the admission of air direct to the gases. That this area should be made up from holes $\frac{5}{8}$in., or at most $\frac{3}{4}$in. diameter, spread over the furnace fronts, doors, and bottoms of back bridges. (3) That, even having this provision for air supply, with the thickness of fire necessary in practice, it is extremely difficult to get a rate of air supply of over 20lb. per lb. of coal, and that the chances of the air supply being deficient are much greater than that of its being excessive. (4) That with a sufficient and properly distributed supply of air direct to the gases, the same rate of evaporation can be obtained from a boiler as with the air passing up through the fires only. That the coal consumption will be reduced some 10 per cent., while the smoke will be diminished fully 50 per cent. both in intensity and duration.

We desire to direct particular attention to the second clause in the preceding statement. It is very commonly taken for granted that any quantity of air can be got through a grate; and that the reason why smoke is produced when it is admitted through the grate alone, is that the air is not properly mixed with the gases. It is never assumed that there is an absolute deficiency of air. It is supposed that if there is not, say, 24lb. of air per lb. of coal, then the coal will not burn; that, in fact, the quantity burned in a given time is determined by the air admission, and by nothing else. This, instead of being the whole truth, and nothing but the truth, is shown by Mr. Spence to be only partly true. It is quite possible for the coal next the grate to get air enough for combustion. It gives out heat, which is employed in distilling the coal higher up in the furnace, which is not really burned at all any more than the coal in a gas retort is burned. The action takes place more or less in all furnaces, and the gas resulting from distillation will be wasted unles it gets air enough for combustion.

Mr. Spence having concluded his experiments with natural draught, next undertook a series with forced draught, and arrived at the following conclusions :—"(1) That a very considerable area for air direct to the gases must be supplied to insure efficient combustion and reduce smoke. (2) That in designing a grate for forced draught the ratio of open air space between fire bars to total grate surface should be much less for forced than for natural draught. (3) That a moderate air pressure of about 0·35in. water in the ashpit, giving a rate of combustion of about 35lb. coal per square foot grate per hour seems more economical than greater air pressures with increased rates of combustion. (4) That by the use of moderate forced draught a higher efficiency of combustion is obtainable than by using natural draught simply. (5) That in order to make a commercial success of any arrangement for raising the temperature of the air for combustion by the waste heat of the escaping gases, the heater would require to be very efficient and of small first cost and up-keep."

It is worth notice that the gain derived from heating the blast to a temperature of 264 deg. Fah. was very small, at the most not more than 4 per cent. That forced draught is not necessarily productive of economy is proved by some of Mr. Spence's experiments. No air being admitted to the gases, as much as 39·5lb. of coal were nominally burned per square foot of grate, although only 17·1lb. of air per lb. were sent through the fire bars. The boiler evaporated from, and at 212 deg. Fah. 9·41lb. of water per lb. of coal, its efficiency being 0·667. With natural draught, under the same conditions of no air to the gases, the evaporation was 9·166lb., or 2·6 per cent. in favour of forced draught. When, however, air was properly admitted to the gases, there was an economy of 13·5 per cent. in favour of so admitting it, and a gain of 4·1 per cent. in favour of forced draught, so that the absolute efficiency of the boiler and its economical efficiency as well were augmented. It was also found that, the higher the pressure of the air and the smaller the grate, the worse were the results obtained. The paper concludes with a suggestion to the effect that a series of trustworthy public trials ought to be carried out with the object of supplying some definite information on a subject concerning which very little is practically known, and concerning which a very wide difference of opinion exists.

ECONOMY OF HEALTH IN WORKSHOPS.—II.

(*Continued from page 77.*)

the floor, and one or more pipes being led down from near the ceiling, to carry off the gas fumes, etc.

The speed of the fan may be regulated by stepped pulleys, like a lathe, or by cone pulleys and belting, or by curved cone friction pulleys, like a potter's wheel. A readier way of checking the draught is by a valve in the discharge shaft, either a throttle valve or a return escape valve; but in these cases the fan has the wear and the power of full speed at all times, while the speed regulation economises both wear and power. This regulation of the whole room should be controlled by the foreman, but the separate air-inlets may be left to the men near them. In selecting a ventilating fan, its specially light work must be remembered. The high speed blast fan is utterly wasteful as a ventilator, and the best forms have very large airways throughout, with little frictional surface, fine cutting edges, and truly curved vanes, so as to lightly pass a great bulk of air. These principles are ignored by many makers of fans, the result being that many are in the market which show only from 30 to 60 per cent. of the efficiency of the best designs; and though I believe we have not yet seen the best possible form, I feel warranted in saying, as the result of several experiments, that the "Blackman Air Propellor" is a long way the best fan I have yet seen for light work, but it will not do well for more than 1in. of water pressure, and so is unsuitable for blast purposes.

Where ventilation is thus forced, it is not needful to have so large outlets as those recommended for natural ventilation, but it is well that the sizes of outlets and shafts, etc., should be arranged for an air speed not exceeding 600 lineal feet per minute. The inlets should be, as already advised, arranged for a speed of about 200ft. per minute to avoid strong draughts.

In order to warm the cold draughts from the air-inlets, the heating pipes should be looped or fitted with "gills" or flanges opposite each inlet, and it is well to counteract the cooling effect of large windows by loops of heating pipe round them.

LIGHTING BY DAYLIGHT OR ARTIFICIAL LIGHT.

No rules can be given as to the extent of window or skylight area required, as it depends so much on the particular class of work, but it is good policy to provide plenty of glass in any workshop. What I wish to urge is the importance of selecting suitable glass, avoiding the very rough surface kinds often used, and selecting either thick sheet glass or rough plate glass; this last having the advantage of being much warmer than thin glass. The cleaning of windows and skylights is most unwisely neglected by many engineers, who thus incur heavy gas bills, and make their shops perpetually dull and unhealthy from sheer thoughtlessness. A little calculation would soon prove that the cost of frequent window cleaning would be well repaid by the comfort and gas economy resulting from it. Skylights collect dirt even more than windows, and should always be arranged with ready means of access for cleaning.

Where much gas light is used, care should be taken to provide adequate ventilation for the time of use only, estimating one ordinary burner to require as much air as four men. So if each man has one gas burner, five-fold ventilation should be used whenever the gas is lighted.

WATER SUPPLY, DINING ROOMS, ETC.

One of the duties of proprietors is to provide good drinking water for men, and also reasonable accommodation in the way of "steam kettles," "hot hearths," "steam ovens," etc., to enable the workmen to make the best of their scanty supplies of food. When one sees during meal times the men from some large works loitering round the nearest public house, or sheltering against the walls in the streets, it is evident that an economy of their health and strength would be affected by the master who would provide them a really comfortable dining room. Indeed, I am inclined to go still further, and venture the opinion that in every works good washing accommodation should be provided, and that a moderate outlay in engineering papers and illustrated newspapers, would so cultivate the men's power of understanding drawings, and so add to their interest in engineering work, as to well repay its cost.

SEWERING AND WASTE APPLIANCES.

I think all will agree with me that the abominably filthy condition of the yards and closets of many engineering works is really disgraceful to the owners, and must be injurious to the men. Let us go to the worst part first, and see what should be done to make the closets reasonably decent and cleanly. I know that some employers intentionally make them too much exposed and inconvenient in order to deter men from idling there; but I think no industrious fellow was every yet led into idle habits by a comfortable closet, and no idle fellow was ever cured of idleness, though he might be made to idle somewhere else, by an inconvenient closet. The right policy is to encourage habits of cleanliness and decency everywhere, and not risk a man's health and offend his decency whenever he visits the closets.

If tub closets are used, care should be taken to avoid leaky tubs, and to fit them closely up to the seats. The floor of cement or flagging should be well sloped to a gutter, and the partitions should be kept six inches above the floor to facilitate washing it. Urinals are best faced with slate, on account of its impervious and smooth surface. Flags or brick walls should be well coated with pitch, laid on hot, to form a good surface, and this can easily be renewed when needful. The waste grids and surface water grids should all be set in stone or earthenware dishes, with glazed earthenware "gullies," or traps underneath. Iron traps are objectionable on many grounds. It often happens that blow-off pipes from boilers, or other such fittings, are turned into the sewers without trapping, but this should never be done. Roof pipes, when not too low, may well be connected directly to the sewers to act as ventilators. It is a very good plan to have a manhole built on the sewer where it leaves the works, so as to give the means of seeing the condition of the sewers at any time, and of clearing them if required. At the outlet side of this manhole a syphon pipe should be inserted, to prevent the public sewer emanations from entering the place, and a vent pipe should be carried up from the public sewer to some convenient height.

I think the most unobservant would admit that by proper attention to health in the workshop, any man now working in an uncomfortable and unhealthy shop, might be made at least one per cent. abler, more active, and more efficient in his work. Taking an average workman to be worth £100 a year to his employer, this 1 per cent. is £1 per year, or equal to £20 of capital. All that I have suggested would not cost £20 per man; in most shops not £5 per man; so I hope that both on the low ground of mere money value, and on the high ground of duty to those dependent on you, my paper may convince you of the true "Economy of Health in Workshops."

In the discussion which followed, the Chairman remarked that if they only took a commercial view of the question which had been dealt with in the paper, it was greatly to their advantage, and also a matter of economy, to study the health of their workmen. The question of ventilation was an exceedingly important one, in engineers' shops, and particularly where there was a quantity of metal dust floating in the atmosphere. The flooring was also an important consideration, and he had been pleased to see that in most English workshops there was a good flooring. A bad flooring greatly contributed to the quantity of dust to be found in a shop.

Mr. Nasmith, in moving a vote of thanks, said Mr. Corbett was well within the mark in the statements which he had made, and the general tendency of the paper was likely to lead to good results. The whole question resolved itself into one of time. In the workshops erected during recent years, he did not think they would find any flagrant disregard of sanitary and ventilating requirements. Many of the old workshops were no doubt badly constructed and arranged from a sanitary point of view, but the number of those places was yearly becoming less. With regard to lighting, there was no doubt before long electricity would be the medium in most workshops; and the light of the future seemed to him to be the large glow lamps which had recently been designed.

Mr. Boswell, in supporting the vote, said there was a difficulty in the ventilation of some workshops, as they had to be built for special purposes. Architects and ventilating engineers were still so much disagreed about the most suitable methods, that it was difficult to say what was the best course to be adopted.

Mr. Corbett briefly replied, and the meeting terminated.

UNITED STATES GOVERNMENT RULES FOR MARINE BOILER PRESSURES.

I.

The following from *The Locomotive* are the principal rules governing the qualities of boiler plate, and strength of boilers and flues as approved by the United States Board of Supervising Inspectors of Steam Vessels.

STRENGTH AND DUCTILITY OF PLATES.

Iron of 45,000 pounds tensile strength and under shall show a reduction of area of 15 per cent., and each additional 1,000 pounds tensile strength shall show one (1) per cent. additional contraction of area, up to and including 55,000 T. S. Iron of 55,000 T. S. and upwards, showing twenty-five (25) per cent. reduction of area, shall be deemed to have the lawful ductility.

All steel plate of one-half inch thickness and under shall show a contraction of ares not less than fifty (50) per cent. Steel plate over one-half inch in thickness shall show a reduction of not less than forty-five (45) per cent. Steel plate required for repairs to boilers built previous to April 1, 1886, may be used for such repairs when showing a contraction of area of not less than forty (40) per cent.

The pressure for any dimension of boiler must be ascertained by the following rule, viz.:

Multiply one-sixth of the lowest tensile strength found stamped on any plate in the cylindrical shell by the thickness—expressed in inches, or parts of an inch—of the thinnest plate in the cylindrical shell, and divide by the radius or half diameter—also expressed in inches—and the quotient will be the pressure allowable per square inch of surface for single riveting, to which add twenty per centum for double riveting.

Boilers built prior to February 28, 1872, shall be deemed to have a tensile strength of 50,000 pounds to the square inch, whether stamped or not.

Where flat surfaces exist, the inspector must satisfy himself that the bracing and all other parts of the boiler are of equal strength with the shell, and he must also, after applying the hydrostatic test, thoroughly examine every part of the boiler.

The hydrostatic pressure applied must be in the proportion of one hundred and fifty pounds to the square inch to one hundred pounds to the square inch of steam pressure allowed.

No braces or stays hereafter employed in the construction of boilers shall be allowed a greater strain than 6,000 pounds per square inch or section, and no screw-stay bolt shall be allowed to be used in the construction of marine boilers in which salt water is used to generate steam. But such screw-stay bolts may be used in staying the fire boxes and furnaces of such boilers, and not elsewhere, when fresh water is used for generating steam in said boilers.

(To be continued.)

CORRESPONDENCE.

We do not hold ourselves responsible for the opinions of our Correspondents.

STRENGTH OF LAP JOINTS.

To the Editor of "The Practical Engineer."

SIR,—The question I forwarded to you last week on the above subject is partly answered in this week's issue by "W. A." He seems to think that I do not understand the question which I sent, and which he has partly answered. The question was given in the Honours Paper in Machine Construction, by the Science and Art Department, 1885. As no material is mentioned, the examiners, no doubt, expected an answer from the data given, independent of the material. I would kindly refer "W. A." to Professor Unwin's book on Machine Design, chap. 4, "Riveted Joints." The probable values there given are $f_b = 1\frac{1}{2}$ to $2\ f_t$, and $f_s = \frac{4}{5}\ f_t$. It will be seen that these values agree approximately with those given in the question. —I am, sir, yours, etc., HARRY THORP.

Feb. 10, 1888.

BOILER REGISTRY AND INSPECTION BILL.

To the Editor of "The Practical Engineer."

SIR,—I should like to call attention to the remark made by the chairman of the Oldham Chamber of Commerce, S. R. Platt, Esq., anent the above Bill, viz., that it can be looked upon as a grandmotherly proposal, and that the Bill is unnecessary; I think, and most people will think the same, that as some boilers are worked it is time there was something done with the novices, or, in other words, the ignorant men who go and offer their services for a mere nothing, deprive a good man of a job, and perhaps endanger the lives of hundreds of people. I think it would be as well if Mr. Platt were to look to the public interest a little more than he has done this time, and less at the masters'. It is all very well for him to say that there are boiler insurance companies and such like, but what good are they? They, as a rule, satisfy the master that his boiler is all right, and so on; but look, for instance, at the Dudley Boiler Explosion. Whoever read that it is any good to lock the stable door after the horse is gone? What we want is the Act passed, and this added to it if it is not added already :—"That no man can have the charge of engines or boilers without a Board of Trade certificate." Then the master or boiler owner will know who is working his boilers, and the public can be better satisfied. Although not in all cases would this prevent explosions, yet it would in a great many. Look, for instance, in the agricultural districts, at the individuals who have the care of boilers, and even in some manufacturing towns. I know of several places in Leicester, and other towns, where the proper man—stoker as he is called—has to go out on errands, and sometimes is away for more than an hour, and anybody looks after the boiler in the meantime. If, while he is away, an explosion occurs, is Mr. Platt going to make the public believe that a boiler insurance co. is sufficient for all that? I think that enginemen and firemen, not novices, are like the tortoise, they are slumbering while this important work wants support. The public will help, I feel sure, if that is what you want. Hoping that this will be seen by all who have to trust to steam as a motive power.—I am, yours, etc.,

Leicester, Feb. 13, 1888. PUBLIC INTEREST.

POLLITT AND WIGZELL'S ENGINES.

To the Editor of "The Practical Engineer."

SIR,—Like yourself, I am of opinion that it is a mistaken idea (though often put forth) that the fact of one of the low-pressure piston rods passing through the high-pressure ports can be altogether responsible for the defect—often met with in this class of engine—of the pressure in the cylinder not reaching near the boiler pressure. It is true that the steam has to be divided, but the area of the two passages round the piston rod is quite sufficient to compensate for the division, and quite as large as the rest of the portway. The real reason, I think, is simply that the steamways are generally too small in area, taking into consideration the length. The low-pressure piston rod is to blame, insomuch that it causes the H.P. steam chest to be placed away from the cylinder, and the ports are also brought towards the centre of steam chest, so that one short slide valve, with a cut-off valve working on its back, is all that is necessary for distributing the steam. Very simple, but is it economical? Let us examine a little further, and we find that these long portways must be filled with steam without doing their equivalent work every stroke of the engine, so that it is absolutely necessary to make them of the smallest area possible to minimise this waste; but even then they cannot be economical. I know of cases where 20 per cent. has been saved in the coal bill, by taking out a cylinder of this class, and putting in another with a different arrangement of valves and ports. This system of contracted steam ports is also often noticeable in the low-pressure diagram, causing, in many cases, a great fall from the terminal in the high pressure cylinder, to the initial in the low-pressure cylinder, which is incompatible with economical working. I should like to know "J.W.J.'s" reason for ejecting his condenser water at such a temperature as 120°. 80° or 90° would show a better vacuum, but, perhaps, the air pump has quite enough to do.—I am, yours truly,

Feb. 13, 1888. L. R.

To the Editor of "The Practical Engineer."

SIR,—May I respectfully suggest that you should publish the diagrams so highly spoken of in the editorial note at the foot of "J.W.J.'s" letter, under the above heading. Readers would then have opportunity for judging whether the comparatively near approach of initial pressure to that in boilers is obtained legitimately, as may not be the case when the high rate of piston speed of the engine in question, and the fact that the small cylinder is doing two-thirds of the work, are taken into consideration.—Yours, etc.,

J. S. S.

[We will try and reproduce these diagrams for our next issue.—ED. *P. E.*]

MARINE PROBLEMS.

To the Editor of "The Practical Engineer."

SIR,—"R.J.G," in your issue of Feb. 3rd, asks two distinct questions, and I think "C." and "W.A." are not looking at the query as put in No. 2. If they will refer to the question they must see the conditions are not as they have assumed, viz., a vessel drifting with the current, but heading against the current, which is a totally different thing from "free to move in and with the current," as put by "W.A." "W.A." goes on to say, "If we suppose the boat anchored or moored with a broadside to the stream, or at any other angle therewith, then the current will exert its force on the up-stream side of the boat, increasing the pressure on that side by that amount which will, etc." This is exactly what I supposed, and I maintain, the question as put by "R.J.G." produces this condition, as the ferry-boat is making a diagonal line with the direction of the stream, which is tantamount to the boat being moored, as the current is leaving the boat in the one case as in the other.—I am, yours, etc., J. R.

QUERIES AND REPLIES.

CHROME IRON.—I should be obliged for the name of any firm who manufacture chrome iron. I want a quantity of castings containing 15 per cent. of chromium.—ANXIOUS TO TRADE.

Answer—We shall be happy to supply you with chrome iron as high as 33 per cent., that you can mix with the castings in any proportion you please. We presume you require it for the purpose of making the iron hard. We have lately had occasion to make a number of experiments with the object of producing a very hard iron. Our attention was turned first to the use of chromium, but we found that its influence in hardening cast iron was very slight unless used in large quantities, and even then was not what we expected, and besides being very costly, it made the iron brittle. We therefore abandoned its use as a practical hardening material for cast iron, and turned our attention in another direction. After a long series of experiments we obtained a metal that was not too dear for the purpose required and much harder than any other with which we are acquainted. It is about as hard as Mushett's steel, and will cut ordinary white iron readily. If this is what you require, we shall be glad to hear from you on the subject.—WARNER & Co., Cargo Fleet, Middlesboro'-on-Tees.

STRENGTH OF LAP JOINT.—In a single-riveted lap joint exposed to tension, determine the diameter and pitch of the rivets in terms of the thickness of plate, and the three stresses f_t, f_s and f_b,

Where f_t = intensity of stress on material of plate.
„ f_s = „ „ „ rivet.
„ f_b = „ bearing pressure,

estimated on a diametral section of rivet. Find the diameter and pitch for ½in. plates when $f_t = 30$, $f_s = 22$, and $f_b = 42$ tons per square inch, and estimate the efficiency of the joint.—H.T.

Answer.—I do not think that "W.A's" answer on the strength of lap joint is quite correct, as he does not determine the diameter and pitch of the rivets in terms of the thickness of plate, and the three stresses f_t, f_s, and f_b as asked by "H.T." The following is, I believe, the correct answer :—Let d = diameter of rivets, p = pitch of rivets, t = thickness of plate, f_t = tearing resistance of plate, f_s = shearing resistance of rivets, f_b = resistance to crushing of plate or rivets, T = resistance of a strip of the joint of width p. Now rosistance to tension $= (p - d)\, t\, f_t$. resistance to crushing $= d\, t\, f_b$, resistance to shearing $= \frac{\pi}{4}\, d^2 f_s$.

The greatest economy of material will be realised when the resistances of the strip to tearing, shearing, and crushing are equal; that is when $T = (p-d)\, t\, f_t$ (1), $T = \frac{\pi}{4}\, d^2 f_s$ (2). $T = d\, t\, f_b$ (3). Equating (2) and (3) we get $\frac{\pi}{4}\, d^2 f_s = d\, t f_b$ and therefore $d = \dfrac{4\, t\, f_b}{\pi\, f_s}$ (4).

Equating (1) and (2) we get $(p - d)\, t\, f_t = \frac{\pi}{4}\, d^2 f_s$ and therefore

$$p = \frac{\pi\, d^2 f_s}{4\, t\, f_t} + d,$$

and substituting for d the value (4) already found, we get

$$p = \frac{4\, t\, f_b\,(f_b + f_t)}{\pi\, f_s\, f_t}.$$

Now if $t = \frac{1}{2}$in., $f_t = 30$, $f_s = 22$, $f_b = 42$, we have $d = \dfrac{4 \times \frac{1}{2} \times 42}{3{\cdot}1416 \times 22} = 1{\cdot}215$in., $p = \dfrac{4 \times \frac{1}{2} \times 42\,(42 + 30)}{3{\cdot}1416 \times 22 \times 30} = 2{\cdot}916$in.

Now, if we assume that there is no alteration of the tenacity of the plates by punching or drilling on making the joint, the efficiency of the joint is simply $\dfrac{p - d}{p}$ that is $\dfrac{2{\cdot}916 - 1.215}{2{\cdot}916} = {\cdot}583$ or $58{\cdot}3$ per cent. — LOUIS F. GRIFFITHS.

[We have received quite a large number of answers to this query, and criticising "W.A's" answer published last week. We have only room for one of these answers, though the others vary but little in their method, and all get the same results.]—ED. *P.E.*

WÖHLER'S EXPERIMENTS.—I should like a formula which will represent the results of Wöhler's experiments on the repetitions of loads. Compare the diameters of the shafts of two engines, the power transmitted and revolutions of each being the same; in one the twisting moment fluctuates between 1¼ and ¾ the mean, and on the other between twice and ½ the mean.—H.T.

MARINE ENGINES.—Why does the centre line of engines not always coincide with fore and aft centre-line of vessel, as in the case of the *Ormuz*. I presume that it is not the screw shaft that is out of line, but that the engines are inclined a little from the vertical?—SHINY BOOTS.

LOCOMOTIVE TANK ENGINES.—What are the tanks of these engines cleaned with, and, why do they prime so furiously on the day after such cleaning?—SHINY BOOTS.

LOAD ON SAFETY VALVE.—Will "T.W." Blackburn, or some other correspondent please say to what pressure the escape valve on pump and safety valve on economiser should be loaded for a pressure in boiler of 100lb.?—T.H.

STEEL CASTINGS.—Would any of your readers give me any information as to the theory of moulding and casting the above? Also if there is any work published on the subject?—MOULDER.

MARINE PROBLEMS.—An engineer once stated that the secret of his success in consumption of coal was owing to the arrangement of his feed pump, part of the water at each stroke being returned to the hotwell. Would this effect any saving of heat, even if successfully carried out, or would the water really remain longer in the hotwell in consequence, though at first sight this would seem to be self-evident?—Q.

COLLIERY PUMPING ENGINES.—Can any of your readers give me the particulars of a pumping engine at Snibston Colliery, in Lancashire; I believe the pump has a 26in. plunger. What was the depth of the mine, and the size of the engines, and has any description or illustration been published in any book?—W.M.

TAPPET MOTION.—Could any correspondent explain, with a sketch, the action of the tappet or plug rod in operating the valves of a Watt's single-acting engine (1769), and his double-acting engine (1784), through the intermediate mechanism, levers, &c.—A.G.K.

STEEL PLATES.—Will some reader kindly give me a list of lengths and widths of iron and steel plates kept in stock by most merchants. What I want is to be able to design tanks, boilers, &c., without having to get them cut, as this increases the labour, and does not add anything to the strength.—H.L.C.

CLEANING SKYLIGHTS.—Which is the best way to clean skylights in an engineering works, where soot and dirt collect and stick fast on the glass? What is the best thing to use with water so as to fetch the dirt, &c., off quickly and cheaply.—J.A.

CROSSLEY AIR PROPELLORS.—The writer would be glad to know the name and address of the makers of this appliance.—G.C.

AUTOMATICALLY CLOSING A STEAM VALVE.—Can any of your readers inform me of a method for automatically shutting, in a given short time, a steam valve that is opened by a movement which is too quick to be utilized for closing it, and where there is no other motive power available? I have heard that a wing valve would be suitable, but have no knowledge of such a valve, and should be obliged for a description of it, or any other method that would answer my purpose.—PISTON.

BRAKE TO PREVENT OVERWINDING.—Could any reader give me a description of the automatic brake to prevent overwinding as used at mines.—W.R.

Could any reader inform me how I am to make the following: I want some aluminium tubes about 1½in. diameter, $\frac{1}{16}$in. thick, and about 1⅛in. long, with flanges on the end. Can I buy the tubes ready made and solder the flanges on, or should I have to get sheet metal, and bend it over, and solder it up all along to make them? What would be the best kind of solder? Is alumiuium very expensive, and who manufactures it?—W Ll.P.W.

TO CORRESPONDENTS.

W.Ll.P.W.—Bell Bros., Newcastle-on-Tyne.

J.C.—We have had other enquiries, and the diagrams will be reproduced.

EFFLUX.—The velocity of discharge is 890ft. per second, corresponding to 65·3lb. per square in. of orifice per minute. The discharge through a $\frac{3}{32}$nd round hole will therefore be ·452lb. per minute. You will find all you want in Clark's Rules and Tables.

STOKER.—A fire, say 9in. thick, is usually considered more economical in fuel than a thin fire. As regards length, 6ft. to 6ft. 6in., is as long as can be conveniently worked by a fireman; a shorter grate for a smaller boiler will be as efficient for its size as the longer ones mentioned above.

J.W.—The temperature in the furnace of a steam boiler is about 1250°. If the smoke is not burned the heat of combustion must be lost, and hence the economy derived from smoke consumption is apparent. The smoke is always at a higher temperaturo than 300°; it is seldom reduced below 500°, except where a good economiser is at work.

HIRWAEN.—The leading screw has two threads to the inch, and you want to cut thirteen to the inch; it is therefore plain that the mandrel must make thirteen turns while the leading screw makes two. What is required then is a train of wheels that will give this velocity ratio. The following wheels will do this: $\dfrac{25 \times 20}{50 \times 65}$, but of course many other arrangements might be found that would answer just as well. 25 and 20 are the drivers, and 50 and 65 the driven.

E. WALTON.—In the reply to "H.J.W.," we were arguing against the need for any locks to keep back the Pacific, even assuming there were a permanent difference of 50ft. If locks are made at all it will be to avoid the necessity of cutting down the channel through the highlands obstructing the course of the canal to the sea level. They will, in fact, be precisely for the same purpose as ordinary barge canal locks, viz., to enable the vessels to ascend and descend a rise in the country, just as the boats ascend to Sheffield through the locks in the canal. As regards the time of completion of the Panama Canal with locks, we are not in a position to say when it will be.

MISCELLANEA.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—The Spring meeting of this society will be held about the end of April or the beginning of May in the city of Nashville, Tenn. Manuscript of papers to be read should be in the secretaries' hands before March 17th.

AVALANCHE ON THE ARLBERG RAILWAY.—The descent of two large avalanches upon the Arlberg railway has buried the station of Langen, together with a mail train, and interrupted communication through the Arlberg Tunnel. A rescue party of 2,000 men was sent to clear away the snow.

SCALES FOR WEIGHING DIAMONDS.—It is said that scales for weighing diamonds are brought nearly to that delicacy of balance which would enable dealers to detect flaws in the stones by minute variations in weight. They weigh accurately the 640th part of a carat.

THE POUGHKEEPSIE BRIDGE.—It appears that it is not to be clear sailing for the Poughkeepsie bridge. A joint resolution is to be introduced in the senate and house, requiring the removal of the stone piers, which it is claimed have been erected without permission of the United States, and to the detriment of commerce.

EXCAVATION FOR THE MANCHESTER SHIP CANAL.—In the work of excavating a marsh on the Runcorn section of the Manchester Ship Canal, there has been laid bare a formation of peat amounting, it is estimated, to several hundred tons. This fuel will be cut into blocks and used for many purposes in the place of coal. On the same section available clay has also been exposed

CONTRACT FOR PERSIAN RAILWAYS.—It is announced that the Cockeril Company of Seraing, Belgium, has not only obtained the contracts for the Persian railways, but also for the delivery and installation of the machinery required at the stations in connection with the service of petroleum pipes between the Caspian and the Black Sea. A Liege firm, Messrs. Chaudoir and Co., have obtained the contract for the pipes.

THE LONDON AND NORTH WESTERN RAILWAY COMPANY.—At the half-yearly meeting of this company, held on Tuesday, Sir Richard Moon reported that they were now working 1,833 miles on absolute block system. The replacing of the old by the new system had cost them £9,300 in the half-year, and from first to last it had cost revenue within £7,000 of £1,000,000. The increase in the carriage repairs had been very much, owing to the improved accommodation they were giving in the carriages; but they had also been replacing the old Clarke brake with the vacuum brake. Two-thirds of the stock were now fitted with the vacuum brake, and about 700 carriages were already fitted with the automatic vacuum brake.

Boiler Explosion.—An explosion of a boiler at Grays, Essex, on the 30th ult., resulted in damage to property to the extent of about £1,000. The fireman was hurled into a pit some 20 yards distant from the boiler, and was severely bruised and shaken; another was also slightly hurt. The explosion occurred in the night when there were only 20 or 30 hands on.

Machinery and Hardware Export Catalogue.—We have received the third annual export catalogue of machinery and hardwares published by The Machinery and Hardware Co., Limited, 147, Queen Victoria Street, London, and notice that it contains the names of many of the principal manufacturers of specialties in hardware in the country. The catalogue is well indexed to facilitate easy reference, and will doubtless prove very useful to buyers in making up their order sheets.

Private Bills.—The following private bills have received notice of motion in Parliament: Sir H. Roscoe—Bill to provide technical education in England and Wales; Mr. Burt — Bill to amend the Employers' Liability Act, 1880; Mr. Kilbride — Bill to promote technical education in Ireland; Mr. Byrne — Bill to amend the Employers' Liability Act, 1880; Mr. Channing—Bill to make further provision for the safe working of railways.

North-East Coast Institute of Engineers and Shipbuilders.—We have received parts 2, 3, and 4, vol. iv., of the transactions of this Society, containing the papers read at the meetings of November 16th and December 7th and 19th respectively. The subjects of these papers are—Notes on Speed Calculations; Influence of Coal Consumption on the Design and Efficiency of Cargo Steamers; Improvements in the Construction of large Stern Frames, Rudders, and Keels; Compound Steam Turbine and its Theory.

Closing of Welsh Iron Works.—The Ruabon Iron Works of the New British Iron Company, the most extensive works in North Wales, were, on Wednesday the 8th, closed in consequence it is said of the continued depression in trade. The blast furnaces are extinguished, and the usual 14 days' notice having expired, all the ironworkers are discharged. Many of the workmen are emigrating, while others are leaving North Wales for Lancashire, Yorkshire, Staffordshire and South Wales.

Welded Steel Tubes.—According to a short paper read before the Engineers' Society of Western Pennsylvania, on Jan. 17, Mr. Thomas J. Bray has succeeded in the manufacture of welded steel tubes. The paper does not enter into the process, but makes the claim that from a special steel made in a Bessemer converter a product is obtained which is tough and yet smooth in working, and fully overcomes the difficulties of manipulation in the form of tubing, in threading, butt-welding, etc.

Dreadful Accident in New York.—A frightful accident occurred on Tuesday in the Broadway, Brooklyn. An electric railway is being constructed through that street, and some iron girders were being hoisted up to the level of the railway by means of a heavy derrick, when the latter fell, with a terrible crash, upon a tramcar which was passing. The car, which contained twenty-five passengers, was smashed to pieces. Four persons were killed on the spot, and fifteen were injured. One sustained such hurts that recovery is hopeless. The horses of the car were killed.

Proposed New Line of Steamers.—It is said that the Delegate General of the United States at the Barcelona Exhibition is actively exerting himself to induce the Spanish Government to establish a direct line of steamers between Barcelona and New York, with a view to increasing the mercantile relations between Spain and the United States. The President of the Exhibition and the Marquis de Comillas have the matter under consideration, and it is stated that should the Government comply with the representations made, the Marquis would be willing to establish a line on condition that the Transatlantic Company should be permitted to continue the service on a permanent basis after the termination of the Exhibition.

Engineering Society, King's College, London.—On Tuesday, at a general meeting of this society, Professor Kerr, F.R.I.B.A., in the chair, a paper was read on the "Roof of the National Agricultural Hall, Kensington," by Mr. A. T. Walmisley, M.I.C.E., an honorary member of the society. In the unavoidable absence of Mr. Walmisley, the paper was read by Mr. C. Cutler. In the discussion, after the reading of the paper, Professor Kerr said that to cover an area with a single span of 240 or 250ft. was a very difficult matter on account of the thrust. In the roof of St. Pancras station, the thrust is taken by the base; in the roof of Olympia it is taken by abutments composing the gallery. The chief points to be attained are lightness and rigidity. Mr. Gask thought the roof appeared to be very light. Mr. Jones spoke on the subject of wind pressure; the wind pressure in this roof is put down at the low number of 30lbs. per ft. super. A vote of thanks was given to Mr. Walmisley, and also to Professor Kerr, and the meeting adjourned.

SELECTED PATENTS.

APPLICATIONS FOR LETTERS PATENTS.

February 3rd.

1600 Metallic Bedsteads, T. Kendrick, Birmingham.
1601 Receptacles for Letters, W. Brampton, Birmingham,
1602 Extinguisher for Lamps, H. Wakefield, Birmingham.
1609 Throwing a Line by Means of Compressed Air, J. D'Arcy-Irvine, Dublin.
1610 Springs, A. F. Mulliner and H. W. Robinson, Northampton.
1613 Boilers for Heating Water, W. Foulis, Glasgow.
1614 Recording Times of Arrivals and Departures of Workmen, A. Dey, Glasgow.
1618 Plate Closing Riveting Machine, O. Smith, Glasgow.
1621 Valve Gear, C. H. Benton. London.
1625 Hoists, Cranes, &c.. E. T. Cleathero, Kent.
1626 Frictionless Gate-springs, A. Beer, Darlington.
1629 Metallic Railway Sleepers. F. S. Morris, London.
1633 Flame Destroying Cartridge, R. H. Edmundson and J. Smethurst, London.
1634 Automatic Regulating Gas Tap. H. Cox, London.
1638 Weighing Machines, H. Allchin, London.
1650 Fluid Pressure Motors, R. K. Evans, London,
1652 Steam Ferry-boats. J. Standfield, London.
1654 Railway Buffers, H. H. Lake, London, (A. B. Ibbotson, of the firm of Ibbotson, Bros., and Co., Limited, London.)
1655 Rotary Printing Machines, H. H. Lake. London. (The Soci Paul Auguste Godchaux and Cie.. France.)
1661 Multiple Needle Sewing-Machine, A. B. Dobell and C. E. Do London.

February 4th

1667 Tools for Grooving and Moulding Wood, E. Preston, Birmin
1673 Automatic Self-feeding Lubricators, J. Titley and T. Kissack Lancashire.
1674 Making Piston Rings, Cylinders, and Cylinder Liners. W Buckley, Sheffield.
1676 Pumping Engines, J. W. Melling, Manchester.
1678 Speed Regulators for Steam Engines, E. C. Mills, Manchester.
1686 Automatic Vacuum Brakes, F. W. Webb, London.
1705 Compound Gas Engine, W. J. Crossley, London.
1706 Compound Gas Engine, F. W. Crossley, London.
1709 Rope Making Machinery, E. Ranson and C. A. Soderberg, London.
1711 Speed Indicators, C. Spratt, Kent.
1712 Steam Boiler Furnaces, D. Justice, London.
1713 Firing Submarine Mines, J. T. Bucknill, Southampton.
1716 Steam Engine Indicators, W. F. Brown, Providence.

February 6th.

1718 Pulleys or Band Wheels, F. W, Wetherell, Stockton-on-Tees.
1740 Producing Designs upon Metal Plates, F. Hall, Sheffield.
1744 Buffers, F. S. Morris, Adelphi.
1745 Mechanism of Watches, G. Hughes, London. (A. Kaiser, Switzerland)
1755 Packed Cocks and Valves, B. Rhodes. London.
1756 Steering Apparatus. J. Brierley, W. W. Brierley, and C. F. Gee, Dover
1759 Expansion Regulating Gear, H. J. Haddan, London.
1763 Boring or Tunnelling Machines, R. Stanley, London.
1767 Manufacture of Pulleys, G. W. H. Brogden, London.
1773 Apparatus for Cutting Gauge Glasses, A. Heggie & J. Raven, London
1778 Screw Conveyors, Eugene Kreiss, London
1780 Hydrocarbon Motors. E. Butler, London
1781 Hydrocarbon Motors, E. Butler, London

February 7th.

1789 Marine Speed Register, R. Potter, Hull.
1793 Corrosion of Screw Propellers, D. Johnston, Glasgow.
1795 Combined Steam and Hand Steering Gear, R. Richardson, Glasgow.
1808 Oil Cans, E. W. Rider, London.
1810 Rotary Engine, F. T. Thomas, London.
1812 Railway Brakes, S. Kay. London.
1819 T-Squares, Edmund Lucas, North Kensington.
1822 Pumping Machinery, Johann Bondkowski.
1824 Steam Generators, Alfred Julius Boult. (Anton Stehlik, Austria.)
1825 Signalling Apparatus, William Henry Childes and William Leslie Milne, Liverpool.
1837 Riveting Machines, Henry Harris Lake, London. (John Leonard Saxe, United States.)

February 8th.

1855 Rotary Automatic Windmill, W. H. Greenwood and J. Rigby, Lorks.
1866 Stopcocks for Boiler Gauges, Alexander Robertson, Glasgow.
1867 Manufacture of Tubes for Boilers, S. E. Howell, Sheffield.
1871 Furnaces for Aiding Combustion, J. Beveridge, Barrow-in-Furness.
1880 Instrument for Setting Saws, John James Harley, Liverpool.
1883 Wrenches, Edward Robotham, High Holborn.
1893 Door Springs, Samuel Henry Ridge, London.
1897 Forced Blast, Robert McIntyre and Hugh McIntyre, Glasgow.
1899 Dry Gas Meters, John Leslie Cloudsley, Westminster.
1916 Caloric Engines, W. A. G. Schonheyder, London.
1920 Lathes, E. Ruf and W. Kumpfmiller, London.
1921 Filter Presses, L. Gismondi. London.
1923 Filter Presses, J. A. Drake and R. Muirhead, London.
1925 Operating Sludge Pump Valves, J. A. Drake and R. Muirhead London.

February 9th.

1938 Testing Boiler Tubes, J. Wotherspoon and Messrs. A. and J. Stewart Glasgow.
1940 Mathematical Compasses, J. F. Bennett, Sheffield.
1653 Lathe Chuck, B. Sutcliffe, London.
1962 Hydraulic Presses, C. Cornes London.
1974 Locomotive Boilers, F. W. Webb, London.
1983 Portable Scaffolding, H. Birkbeck, London. M. Kruse, Stockholm
1998 Screw-Propellers, H. H. Leigh, Middlesex. (J. N. Le Solliec, France).
1999 Screw-Propellers, W. R. Freeman, Middlesex.

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EDITORIAL NOTICES.

All communications for the Editor of this Journal should be addressed to the Manchester Office, 3, Grosvenor Chambers, Deansgate, Manchester.

Communications intended for insertion in the current week's issue should reach us not later than Tuesday Evening.

We cannot undertake to return rejected manuscripts or drawings unless accompanied by a stamped and directed envelope.

Contributors are requested to write on one side only of the paper. Sketches should be sent on separate sheets.

TO ADVERTISERS.

Advertisements intended for insertion in the current issue should reach us on Wednesday morning at the latest.

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NOTICE TO NEWSAGENTS AND SUBSCRIBERS.

Numerous complaints having been made to us by Subscribers of the difficulty they experience in obtaining copies of the *Practical Engineer* in certain districts, we have to state that the Journal can be obtained by any Newsagent through the ordinary Trade channels, and no difficulty should therefore exist in obtaining copies by order of any Newsagent.

For the information of the Trade, we may state that copies can be obtained from either of our Offices in London or Manchester, or from any of the following wholesale houses, who are also supplied with Contents Bills for the use of the Trade:—

W. H. SMITH & SON, Strand, London.
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GEORGE BROMBY, 26, Charles Street, Hull.
EDWARD KING, 37, Greyfriars Lane, Coventry,
&c., &c., &c.

Important Notice to Newsagents and Subscribers.

After the current issue our Publishing Offices in London will be at 11, PATERNOSTER BUILDINGS, E.C., where the Trade will in future be supplied.

Simultaneously with the above change, our PUBLISHING OFFICES in MANCHESTER will be REMOVED from Grosvenor Chambers, Deansgate, to more commodious and convenient premises at 6, VICTORIA STATION APPROACH, where all communications intended for the Manager or Editor should be addressed after the 28th inst.

We take this opportunity of thanking our Subscribers for their continued and increasing support; the circulation of the "Practical Engineer" having undergone a STEADY and CONTINUOUS INCREASE during the past few months. This fact encourages the proprietors to persevere in their determination to make the Journal still more worthy of the support of the classes for whose benefit it was established, and to spare no effort or expense to attain this result. At the same time they will be glad at all times to receive any suggestions which may be calculated to assist them in their efforts to produce at a merely nominal price, a journal which shal lbe alike creditable to the profession which it represents, and useful and instructive to its readers.

NOTES.

The American genius for invention seems to be finding its vent now in methods of heating railway carriages by steam. A serious difficulty in the way of heating by steam from this locomotive is the connections of the pipes between each carriage. The Erie Car Heating Company overcomes the difficulty by means of a coil of brass tubing, and a sliding joint or piston, which makes the joint flexible. The coil of pipes under each carriage allows of the necessary deflection, and avoids leakage, which generally accompanies a ball joint. The piston draws out when the cars are uncoupled.

If the present rate of progress on the Forth Bridge is not interrupted by bad weather, it is expected the structure will be completed by October of next year. The three cantilevers have been carried to their full height, 370ft. above water level. The lateral extensions have also each been carried out to about 160ft. on each side of the three piers.

The guarantee fund for the Glasgow International Exhibition approaches £300,000, and a revenue of £42,000 has already been secured, including £20,000 for the refreshment department. It will appear, therefore, that the prospects of the Exhibition are exceedingly good. The building is 1200ft. long by 265ft. wide, and will afford an area for exhibits of nearly 320,000 square feet, making it the largest Exhibition held in this country since 1862. Space has been applied for by 2,200 exhibitors, and allotted to 1,400. There will be a fine art department, with sculpture as a prominent feature, and a "Bishop's Palace," illustrating ancient Scottish life and manners. The project is exciting a lively interest in Glasgow.

The municipality of Vienna are spending something like £5,000 a day for clearing the streets of snow in the outlying districts, while in addition to this they have contracted with a company to clear the central district of the city. This large outlay has been entailed by what has been so far the heaviest snowfall of the winter, which occurred on Saturday. The railroads in Austria have also suffered greatly through the abundance of snow during the winter. One company alone has, we hear, spent £30,000 in clearing its lines of snow.

The Balance Sheet of the Manchester Exhibition has been published, having been made up to January 21st. There are some outstanding accounts that still require settlement, after which the estimated disposable surplus will amount to a little over £43,000. We think that the Exhibition Committee are to be congratulated on the financial success of their scheme, which contrasts so favourably with some other exhibitions recently held, notably the one at Liverpool. In round numbers the receipts from the principal sources, and the chief items of expenditure, are as follow: Receipts—Admissions, £142,950; Season Tickets, £32,186; Space Allotments, £22,280; Royalties and Concessions, £44,016; Sale of Buildings, £11,994. Expenditure—Buildings, £106,494; Grounds, £6,977; Machinery Foundations and Fittings, £4,170; Electric Lighting, £9,524; Fairy Fountain Displays, £3,943; Illumination of Grounds, £2,768; Music, £17,263; Salaries and Wages, £15,324; Advertising, £14,530; Fine Art section, £5,152; Police, £6,476; Entertaining Special Visitors, £2,380; Rent and Compensation, £6,000. The problem now will be what to do with the surplus.

The Baldwin Locomotive Works have recently completed their nine thousandth engine. Such an enormous output is especially remarkable when it is remembered that the works were not originally laid out for building modern locomotives, and that they labour under some consequent disadvantages, the individual shops being separated by public streets, and many of them being at a considerable distance from the main office. A good system of organisation, and a careful selection of officers and foremen, has probably been the secret of the success of the Baldwin Locomotive Works, which from small beginnings have built up by far the largest business of the kind in the world.

The fifth ordinary general meeting of the Manchester Ship Canal Company was held on Tuesday, when a very encouraging and interesting report of the Company's condition was read by the secretary. It appears that up to the 31st December the amount paid against calls was £1,190,780 on preference shares, and £970,054 on ordinary shares. The whole of the £4,000,000 in preference shares has been taken up, but of the same amount of ordinary shares £616,980 still remains unallotted. It will be remembered, however, that the Company have a right to pay the contractor in £500,000 ordinary shares, should they desire to do so. The expenditure for the half-year includes the following items:—Construction of works, £255,000; engineering and surveying, £4,798. The Directors anticipate a further expenditure on account of construction of works of £550,000 during the current half-year. The working of the Bridgewater Canal has been very satisfactory, and shows a profit of over £30,000 from the 5th August to the end of the year. In consequence of the alteration of the route of the Canal made in the House of Commons in 1885, the Company will be obliged to purchase more land on the Cheshire shore of the estuary, and for permission to do this a bill will have to be promoted in Parliament. To give an idea of the magnitude of the work in progress, the chairman said there were at present 40 locomotives at work, 18 steam navvies, 7 steam excavators, 27 steam cranes, 14 portable engines, 4 pumping engines, 9 steam saw benches, 3 steam tugs, 14 flats and barges, 1,780 waggons, and 2,500 barrows. In addition to the plant, 3,000 men are at present employed on the works.

EXPLOSION OF A RAG BOILER AT NEW MILLS.

A serious explosion occurred on Saturday last, the 18th inst., at the paper works of Mr. J. W. Turner, New Mills, near Buxton, from the bursting of a large revolving boiler steaming rags, employed for etc., used in the process of paper manufacture. Fortunately the explosion occurred early in the morning before the workpeople had commenced their duties, and thus no one was injured; the explosion, however, was of a very violent character, and the destruction of property was considerable, the damage being estimated at between £1000 and £2000, and had it occurred later in the day it must have been attended with serious loss of life. The vessel which burst was a plain egg-ended structure, about 17ft. in length over all, by 7ft. in diameter, the plates being $\frac{7}{16}$in. thick throughout, and was stated to have been made by Parkes, of Bury, about the year 1874. Steam was supplied to the boiler through one of the hollow trunnions on which it revolved. The pressure in the supply pipe was regulated by means of an ordinary lever safety valve, stated to be loaded to about 30lb. on the inch. In the cylindrical body of the boiler there were two large rectangular manholes for charging the boiler with rags, etc., in the first instance. These openings measured 3ft. in length by 18in. transversely, and were placed in line with each other, so that there was only a neck of plating about 2ft. wide between the holes. It should be stated that each opening was stiffened with a ring of angle section riveted on externally, so as to form a mouthpiece, but notwithstanding this the openings were serious sources of weakness, and it was at one of the holes that the boiler gave out in the first instance; the fractures started at the corners of one of the sides of the mouthpiece, and then ran in an irregular manner right round the shell at each end, tearing away about half the boiler, and opening it out nearly flat. From these fractures others started which extended into one of the egg ends, and tore it into two pieces, the larger of which was shot through the roof, and crashed into another portion of the premises. It is just possible the pressure of steam in the kier may have been in excess of that to which the safety valve on the supply pipe was loaded, viz., 30lb., as this pressure was maintained by the exhaust from a small non-condensing engine which worked the revolving machinery, and this engine was supplied with steam at 60lb. pressure from the main boilers. Be this, however, as it may, there can be no doubt that the large manholes were a source of considerable danger, and rendered the boiler much weaker than appears to have been supposed by those in charge.

TRANSMISSION OF POWER.—IV.

BELTS.—IV.

Mr. Geo. Wm. Sutcliffe, in a paper contained in vol. 58 of the Proceedings of the Institute of Civil Engineers, says that Evan Leigh's rule is extremely trustworthy, yielding a good working and economical result; that its correctness has been repeatedly confirmed both by success and failure. The rule is: The width of a double belt in inches is equal to 33,000 multiplied by twice the number of indicated horse-power, divided by the speed in feet per second, multiplied by the length in inches of the arc of contact on the lesser pulley.

Formula:— $$\text{W} = \frac{66000 \times \text{I.H.P.}}{\text{L} \times \text{V}}$$

Where W = width of double belt in inches, L = length of arc of contact upon lesser pulley in inches, V = velocity of rim in feet per minute. This rule makes no difference for different lengths of belts, except that accounted for in the length of the arc of contact. There is an impression current that long belts are more effective than short ones, but this cannot be the case in those that are vertical or nearly so. Short belts require a closer attention to maintain a constant tension. The usual speed of belting at Lowell, Massachusetts, is one mile a minute, or about 5200ft. with pulleys 10 or 12ft. diameter, and with these conditions the belts are loaded to transmit 10 I.H.P. per inch in width. This is less than the tension arrived at by Evan Leigh's rule, but the Lowell belts are not of first-rate quality.

In the case of small pulleys, the power required to bend the belt round the pulleys becomes an important element in the conditions to be regarded. With pulleys less than 3ft. 6in. in diameter double belts should not be used, as their employment is not economical. Mr. Sutcliffe further states that all arrangements of belt driving are wasteful in power, as evidenced by the fact that longer journals are necessary than with toothed gear connections, and that this is especially the case when the only admissible pulleys are small in diameter. The supporting bearings ought to be as near the pulleys as possible, to prevent deflection and consequent heating.

BELTS AND PULLEYS.

An excellent quality in a belt is elasticity, under certain conditions; a belt that is not elastic, but pliable only, may do its work very well, but it is not so good as a belt that combines elasticity and pliability. A round gut for instance, used for driving machinery is only pliable, but not elastic, and to transmit any force it must of necessity be kept very tight, which throws great strain on the bearings as a natural consequence; but a belt that is elastic will transmit its full driving power if let run slack, and much of the value of leather belts is due to their elasticity, this, and their pliable nature, aiding in their contact with the pulley face. An ordinary bullock's hide is usually permanently stretched five inches before being cut up, but the elasticity of belts made from it is not the least impaired. All new belts have to be taken up after running a short time, but there is a natural elasticity in a leather belt which will cause it to return to its original length when the strain is removed. It is a good practice to release belts from their working strain whenever practicable. An interesting experiment, as follows, proves this :—New leather belts were put on two iron turning lathes at the same time, the lathes stood side by side, the work was similar, and the belts were cut from the same hide; the belt of one lathe was thrown off every night, while that on the other was never released; the latter had to be shortened four times during its existence, while the other was taken up but once, and when the continuously strained belt was so nearly worn out as to require repairs, the nightly released one was in good condition. This treatment of belts is not always practicable, but when possible it should be observed. The strongest part of belt leather extends one third the way through from the flesh side.

Belts should not be run faster than from forty to fifty feet per second, or 2,400 to 3,000 feet per minute, nor endure, according to English practice, a tension of more than 300 lbs. per square inch of section. Where it is possible belts should always run from the top of the driving to the top of the driven pulley; and the pulleys should always be as large as possible, and of the necessary width, together with that of the belt, so that sufficient tension can be put on the belt without unduly straining it.

Though the resistance of belts to slipping is dependent on their breadth, there is no advantage derived by increasing the width of a belt beyond that which is necessary to enable it to resist the strain to which it is subjected. A vulcanised india rubber belt will sustain a greater stress than leather, added to which its resistance to slipping is 50 to 75 per cent. greater; in high speed belting the breadth of the belt should be increased in order to prevent slipping. Long belts are much more effective than short ones, and in arranging for driving by belts this should be borne in mind. In calculating the power that may be transmitted it is only necessary to take the smaller of the two pulleys into account.

For cast iron pulleys there is no better surface than that left by the broad tool coarse feed, so that the pores of the metal may insure a good grip on the belt. It is quite common for iron pulleys to be turned out of hand as though they were intended to offer the least possible resistance to slipping, their faces being made quite smooth, in fact polished, and in practice it has been found necessary to use a medium between the pulleys and belts to prevent the latter slipping off the pulleys if they were anyways hard worked, and were at all slack, or the other remedy resorted to of taking the belt up, thereby shortening its life considerably, and putting unnecessary strains on the shaft bearings.

The following table will be found useful in determining the diameter of pulleys, and the H.P. they are capable of transmitting for any given number of revolutions, with single, double, or treble leather belts, suitable for all ordinary purposes; of course exceptional cases will present themselves, and will have to be dealt with according to the conditions of each particular case :—

Width of Belt in Inches.	Description of Belt.	Least diameter of Pulley in Inches.	H.P. Pulley will transmit per Revolution.
2	Single	6	·0048
3	„	7	·0084
4	„	8	·0128
6	„	12	·0288
8	„	16	·0512
10	„	20	·0800
8	Double	20	·0960
10	„	25	·1500
12	„	30	·2160
14	„	36	·3024
16	„	36	·3456
18	„	38	·4104
20	„	40	·4800
22	„	44	·5808
24	„	48	·6912
26	„	52	·8112
28	„	56	·9408
30	„	60	1·0800
32	„	64	1·2288
36	„	72	1·5552
40	„	80	1·9200
44	„	88	2·3232
48	„	96	2·7648
56	„	112	3·7632
30	Treble	72	1·6200
36	„	72	1·9440
42	„	84	2·6460
46	„	92	3·1740
48	„	96	3·4560
52	„	104	4·0560
56	„	112	4·7040

These dimensions will suit speeds of belts from 2,000 to 3,500ft. per minute. A good approximate scale for the H.P. that a leather belt, either single, double, or treble, will transmit, is the following :—H.P. $= c \times W \times D \times N$.

Where $c =$ ·00075 for treble leather belts.
„ $c =$ ·0006 for double „
„ $c =$ ·0004 for single „
„ $W =$ width of belt in inches.
„ $D =$ diameter of pulley in inches.
„ $N =$ number of revolutions of pulley per minute.

To illustrate the use of the table, we will take the 20in. pulley with single belt in the table, and suppose it is required to make 350 revolutions per minute: then H.P. $=$ ·080 $\times$ 350 $=$ 28, the H.P. that we should expect from a single belt 10in. wide, working over a 20in. diameter pulley. This result may be obtained by ascertaining the number of revolutions the pulley must make to equal any required speed of belt.

The length that a belt should be made may be got by the following method :—To the radius of each pulley add the thickness of belt, their sum multiplied by 3·1416 plus twice the distance between the centres of the two pulley shafts, will give the length of belt when placed on the pulleys; this is for belts that are butted, for belts that are lapped the amount of lap must be added to get the total length. This method assumes that the distance between the pulleys is moderately great, and that there is very little difference in their diameters. Where there is a great difference in the respective diameters, the pulleys may be drawn to scale at their proper distances apart, and the straight lengths measured or calculated by a simple rule. To find length around each pulley, divide the circumference into any number of equal parts, then, as the number of divisions contained in the portion of belt in contact with the pulley is to the whole number in the circle, so is the length to the circumference of the whole circle.

In the case of grooved pulleys there may be a very great difference in the diameters of two round belts, therefore it becomes necessary to get the lengths of these belts very accurately. The radius of the belt must be added to the radius of the pulley, consequently the total length of the belt will vary with its own diameter, and on the same pair of pulleys a larger belt will be longer than a belt of a less diameter. A good plan to get the length of round belts is to make a sketch, showing a section of the groove in the pulley, which varies from 60° to 90°, the size of belt intended to be used should be drawn in the groove so that the amount the belt sinks into the groove may be ascertained, and the distance from centre of pulley to centre of belt got. The previous remarks will apply in getting the necessary particulars to arrive at the proper length of the belt.

T. P.

PROPORTIONS OF EYE-BAR HEADS AND PINS.

Pin joints are much more used in American constructive engineering than in English practice, and Mr. C. Shaler Smith, in a communication to the Transactions of the American Society of Civil Engineers some years ago, arrived at the following conclusions from his experiments upon the above.

1. That a pin whose diameter was two-thirds of the width of the bar was the least size that would develop the full strength of the bar.
2. That the requisite sectional area across the eye for any given width of bar increases with the diameter of the pin.
3. That the best shape of the eye-bar depends on the material and mode of manufacture. "Weldless" eyes should be circular in outline, and "hammered" eyes Gothic in shape, or in other words having 50 per cent. greater sectional area behind the pin than at each side of it.

The author calls attention to the fact that the diameter of the pins is sometimes governed by the bending stress. He gives the following table, where the diameter of the pin is expressed in terms of the width of the bar.

Width of Bar = unity	Diam. of Pin.	No. 1. Hammered Eyes.		No. 2. Weldless Eyes.	
		Metal Section across the Eye.	Max. thickness of Bar.	Metal Section across the Eye.	Max. thickness of Bar.
1·00	0·67	1·33	0·21	1·50	0·21
1·00	0·75	1·33	0·25	1·50	0·25
1·00	1·00	1·50	0·38	1·50	0·38
1·00	1·25	1·50	0·54	1·60	0·54
1·00	1·33	1·50	0·59	1·70	0·59
1·00	1·50	1·67	0·70	1·85	0·70
1·00	1·75	1·67	0·88	2·00	0·88
1·00	1.75	1·67	0·88	2·00	0·88
1·00	2·00	1·75	1·08	2·25	1·08

NOTE.—The numbers given in the table are constants, which being multiplied by the width of the bar, give the proportions of the eye.

Example of the use of the table. Suppose the bar to be 4in. wide × 1in. thick, and the pin to be 3in. diameter, required the proportions of the eye.

1. Hammered.—Sectional area of bar = 4 × 1 = 4. Diameter of pin = 3in. = width of the bar × ·75. Section of metal across the eye = then 4 × 1·33in. = 5·33in. = 2·66 square inches upon each side of the pin, and the sectional area behind the pin = 2·66in. × 1·5 = 4 square inches.

2. Weldless.—Section of metal across the eye 4in. × 1·5in. = 6in. = 3in. upon each side of the pin. The sectional area behind the pin would be 3 square inches, the same as the section on each side of the pin.

The maximum thickness of bar which could be used without putting too great a bending stress upon the pin would be 4in. × ·25 = 1in., the same thickness as assumed in the first instance.

TOOL ANGLES.—III.

(*Concluded from page 65.*)

Returning to the metal working tools, take the common form of drill. Looking at fig. 14, it is seen at once that this is not in theory, whatever it may be in actual fact, a cutting tool, because there is no front rake. There is really a slight overhang of the face A, by reason of the tapering down to the point, seen in the edge view. But fig. 15 is a true cutting tool, because the hollowing out in front provides the top rake at once. Each form of drill has the bottom or clearance angle. But we now see at once the reason why the twist drills are so much superior to the common forms, for the twist furnishes the proper angle of top rake, fig. 16, which remains constant until the tool itself becomes worn out. This takes no account of the free delivery of the shavings, which is also a point of much importance. The old-fashioned drills nevertheless work well, in spite of their overhang, because the guidance is excellent, due to the parallelism of the shank, immediately above the cutting edges, and to the tapering of those edges, by which they are kept well to their work, the cutting forces on each side being strictly balanced. Further, the clearance angle reduces the friction, which would otherwise be excessive. The second form of drill cuts greedily, but the hollowing out is objectionable because it soon becomes obliterated by grinding, necessitating re-formation at the forge, and with the file, and re-tempering.

Every fitter knows in a very practical way the difference between good and bad taps and dies. While some will merely squeeze and scrape, others cut. Nearly all squeeze at one section of the work, but the better the construction, the more does the cutting action predominate. Taking taps first, we know that there are always two, usually three, of the same size to a set—the entering or taper tap, the middle or second tap, and the bottoming or plug tap. The section of the taper tap is that shown in fig. 17, often varying somewhat in the shape of the grooves, but never in the "backing off." If there were no backing off, or relieving, the tap would work with too much friction, and squeeze rather than cut, for the backing off at *b b b* supplies the angle of clearance, which is as necessary in a tap as in any cutting tool used for turning or drilling. Therefore, the cutting points *c c c* enter and penetrate below the surface of the material, while the backing off, *b*, prevents undue and injurious friction; *d* represents the cutting or top face, which does not make any appreciable angle with the work, but stands about perpendicularly thereto. Taps, therefore, barely come within the range of cutting tools proper, perhaps, in strictness, should be classed with the scrapers. In practice, however, the taper tap certainly removes material with the utmost facility, just as does the common form of drill with overhanging cutting face. The backing off is most pronounced in the taper tap, commencing at the bottom end, and dying away within four or five threads only from the top. In the middle tap the backing off is carried up five or six threads only from the bottom end. In the bottoming tap there is no backing off whatever, but the threads are full to the end. The function of the two last is therefore apparent—the completion and smoothing of the work, which the entering tap has begun, and the carrying of threads right to the bottom of blank holes. In these, therefore, the squeezing action predominates. The taps used with small screw plates are not cutting tools, because, being so small, grooving out would make them very weak; their sides are therefore filed flat, giving angles much greater than 90°.

In the dies, similar general results are obtained, though in a different way. Fig. 18 represents a pair of dies at the commencement of cutting, and fig. 19, the same at the termination of the thread. The dies, as drawn, are made on a hob, one depth of thread larger than the screw to be cut. In the figures we see that there is no top rake at all, the cutting edges being radial, like those of the taps. In many dies the faces are not radial, being made parallel with each other, resembling in respect of overhang, the faces of the common drill. But there is a clearance angle *b* in fig. 18, due entirely to the lack of coincidence between the curvature of the die, and that of the rod which has to be screwed. This is clear, because, while at the termination of the thread, the points of the thread in the dies have to coincide with the roots of the thread being cut, at the commencement of the operation the reverse obtains, the points of the dies coinciding with the points of the screw, that is, with the diameter of the rod before screwing. The deeper the thread, the greater will be this disparity; hence, the clearance angle in dies is not due to any backing off, but to the difference between these diameters. It is, therefore, impossible to make theoretically perfect dies of this form; such can only be made on the principle embodied in Sir Joseph Whitworth's well known "Guide screw stock," in which two very narrow moveable cutters are opposed to a fixed guide in the stock, the only function of the latter being to give the proper "lead," and so prevent the formation of drunken threads, which are liable to result from the use of narrow cutting edges. But practically most excellent results are obtained with common dies, though their action varies at every turn. In fig. 18, the action is simple cutting, and is very rapid, because of the small extent of surfaces in contact, the corners *a a* penetrating freely, and cutting with avidity. As the thread deepens, the action glides into that of squeezing, which occurs when the curvature of the dies coincides exactly with that of the thread being cut. Soon, however, the inner slots *c c* begin to operate, and as they cut deeper, reducing the diameter of the thread, an angle of clearance is formed by the corners *a a* being thrown clear of the thread, and at the termination of the cut, fig. 19, the dies are operating with good effect. The action would not be precisely alike in the case of

TOOL ANGLES.—III.

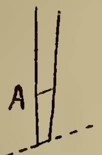


Fig 14

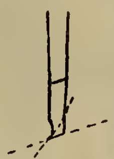


Fig 15

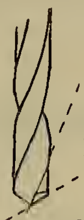


Fig 16

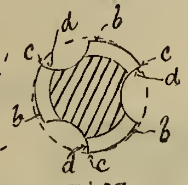


Fig 17

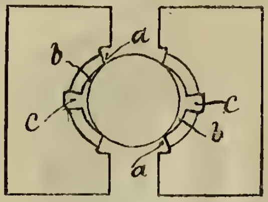


Fig 18

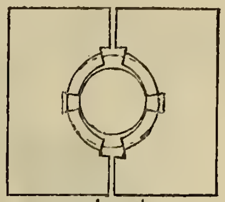


Fig 19

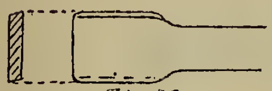


Fig 20

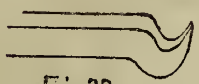


Fig 22

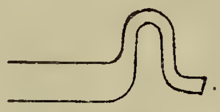


Fig 23

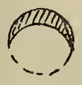


Fig 24

dies cut over hobs either of the same size, or of twice the depth of thread larger than the screw to be cut, but the general action, of the die as a cutting tool is apparent from this, which is the only matter under discussion here.

In strictness we ought to term taps and dies scraping tools, yet considering the facility with which, when properly formed, they remove the material, they seem to act mainly by cutting. But if we draw the line at the perpendicular presentment to the work, and call those true cutting tools only which make an angle of less than 90° therewith, a large number of tools which operate very efficiently must be classed with the scraping division. Thus, the boring bit, fig. 20, is a scraping tool, having bottom rake only; but the D-bit, fig. 21, is a cutting tool because it has both top and bottom rake. The finishing tool, fig. 22, is also a true cutting instrument; but the spring tool, fig. 23, also used for finishing, is a scrape only. Milling tools may or may not act by cutting, depending on whether or not a little front rake is given. Their angles are also very similar, or identical with those of the common rose drill. The cutters set in a boring head may be either lathe roughing tools, or scrapers having bottom rake cnly. The rymers act by scraping only. The common parting tool for metal usually has a little top rake, and therefore cuts. Pursuing the application of first principles into the humbler gimlets and augers, there is no doubt about the mode in which they operate; the nose of the auger has both top and bottom rake, so has the shell of both gimlet and auger, see section of same, fig. 24. The twist gimlet, or twist auger, is formed on the same principle as the twist drill. The centre bit cutter has top and bottom rake, and so has the nose bit. The rotary adze block, which imparts so smooth a surface to boards in wood working machines is but an assemblage of broad scraping chisels, acting perpendicularly to the face of the work. All the various tools used for scraping hard wood and metal, the chasers, and the toothing planes, act perpendicularly. The faces of scrapes for metal and for wood lean over several degrees from the perpendicular. In all these the penetration is very slight, differing from that of cutting tools, which are capable of going considerably below the surface.

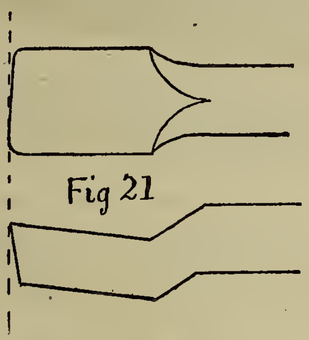


Fig 21

The saws and files may properly be classed with scraping tools, the faces of the teeth standing perpendicularly to the work, or in the case of most saws, leaning over thereto. Only in the case of a limited number of saws, used for soft wood exclusively, and furnished with a trifle of "hook" or "rake," is there any approach to a form of tooth identical with that of a true cutting tool.

This is but a rapid and somewhat limited survey of the important subject of tool angles; queer though their shapes often are, and their purposes not apparent to a casual observer, we see that they are readily reducible to first principles, and by means of a knowledge of these principles, it is not difficult to learn the causes of inefficiency of action when present, and to so modify bad or imperfectly formed types—so to strike the happy mean—that they shall work with the fullest measure of perfection compatible with durability of edge.—J. H.

THE MAGNETIC PROPERTIES OF IRON.

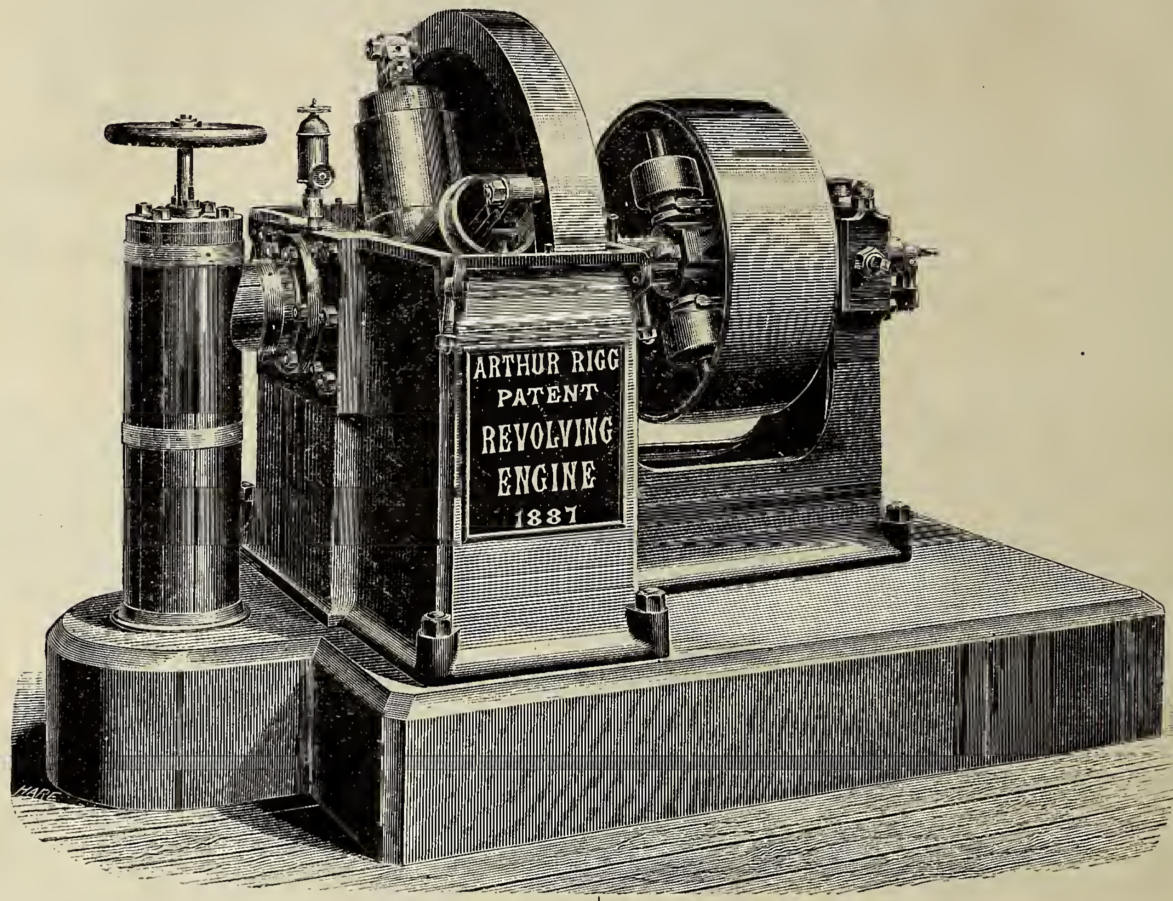
A series of experiments, with a view to determine the temperature at which soft iron becomes non-magnetic, have recently been carried out at the laboratory of the Sorbonne by M. Ledeboer. The bar of iron experimented on was first insulated by being completely covered with mica, over which was wrapped a helix of platinum wire, and the whole was then placed inside one of two exactly similar induction coils, which were connected with a Wheatstone bridge, so that their relative self-inductions could be compared, and would, of course, be equal when the iron lost its magnetic properties. The bar was heated by passing a current through the platinum helix mentioned above, and the rise of temperature was measured by means of a thermopile. The results obtained were that up to a temperature of 680° cent. the iron preserved sensibly the same magnetic properties as when cold, but beyond this temperature the decrease of permeability was very rapid, and the bar became completely non-magnetic at 770° cent.

THE CHANNEL TUNNEL.

A meeting convened by the Mayor was held on Thursday week in Manchester Town Hall, to hear an address from Colonel Hozier on "The Channel Tunnel from a Military and Commercial Point of View." Colonel Hozier urged that if Englishmen were to win back their position as the distributors and warehousemen of the world, something must be done in the way of bridging or tunnelling the Straits of Dover. The foreign and Colonial exports fell from £56,000,000 in 1873 to £33,000,000 in 1885. In 1875, the raw silk coming to England for exportation amounted to 2,300,000lb., and in 1885 it fell to 300,000lb. The value of tea brought to England in 1875 was £1,900,000, and in 1885 it fell to £1,230,000. When the goods were brought by ship to this country, they could not be put on the railway and sent to their place of manufacture. If we had through communication with Lyons there was no reason why silks from London should not be forwarded just as quickly and as safely as they were from Marseilles. While our own imports of produce to be distributed had been steadily falling, those to the Continent direct had been advancing with leaps and bounds. He considered the military objections easily answered, and that the scheme would rather afford military advantages. If we were blockaded, and our mercantile marine lost command of the sea, the tunnel would be useful in enabling us to get supplies from France and other countries.

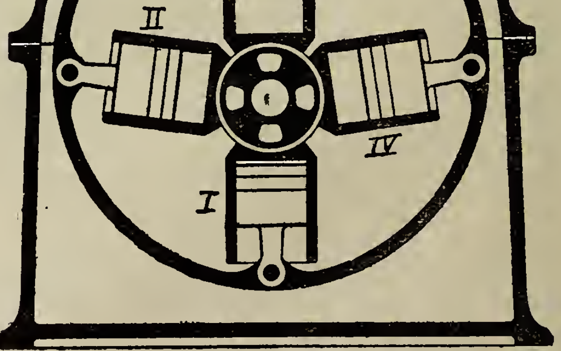
HIGH-SPEED REVOLVING STEAM ENGINE.

CONSTRUCTED BY ARTHUR RIGG, ENGINEER, OLD BROAD STREET, LONDON.



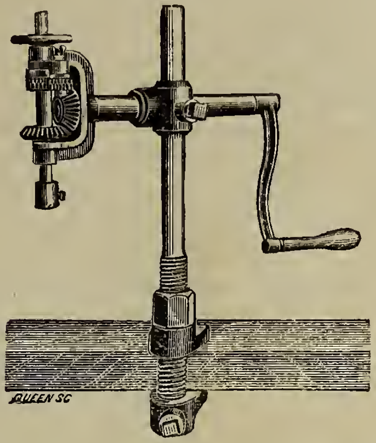
The illustrations herewith represent a new form of high-speed engine, invented and designed by Mr. Arthur Rigg, engineer, London, which is an attempt to overcome the objections to the usual high-speed engines on account of the reciprocating parts which frequently absorb as much as 20 per cent. of the total work done, unless a high average pressure is maintained in the cylinder. With slow running engines the loss from this cause is not so great, and hence an early cut-off may be used, with the resulting economy usually attained by this means. It is mostly because of this difficulty with the reciprocating parts that an early cut-off cannot be applied to a quick running engine as at present constructed, and hence the introduction of the designs illustrated in our engravings to meet these objections. Mr. Rigg, before perfecting his design, critically examined the best high-speed engines in this country and in America. We may mention here that it is sometimes thought that the work done in accelerating the reciprocating parts of an engine at the beginning of the stroke is recovered towards the end; but the compression of the steam in the passages is simply a device partly for bringing the parts to rest gradually, and partly for preventing the impact of the steam at the commencement of the next stroke, which would produce a violent concussion if allowed to expend its full force on the crank-pin. These evils are inherent in all engines with reciprocating pistons.

The full realisation of this conclusion led to the adoption of the revolving engine. The engine has four cylinders arranged radially on a central stud round which they are free to revolve independently of each other. Their pistons are connected to crank pins fixed at equal distances apart, on the face of a wheel which also turns freely round. The centre of the stud carrying the cylinders is a little eccentric as regards the centre of the wheel; this is shown clearly in the diagram. If now the wheel and cylinders are revolved together it will be seen that the pistons move up and down in the cylinders, which movement answers the same purpose as the reciprocation in an ordinary cylinder, although both piston and cylinders are themselves moving round in true circles. Inasmuch, however, as the pistons do move in and out of the cylinders, there must be some acceleration and retardation somewhere, although it may not always be easy to find out where the action takes place. In Mr. Rigg's engine it will be seen that if the wheel carrying the crank pins is caused to revolve uniformly, by, say, a fly wheel, then the cylinders cannot revolve uniformly, but must travel at a quicker rate at one part of a revolution than at another.



By looking at the diagram it will be seen that a cylinder at the top must be revolving more slowly than one at the bottom, because there the crank pin which drives it is further removed from the axis round which the cylinder is turning. In fact the cylinders in turn are being accelerated all the way from the upper position to the lower one, and retarded for the remaining

HAND DRILLING MACHINE.



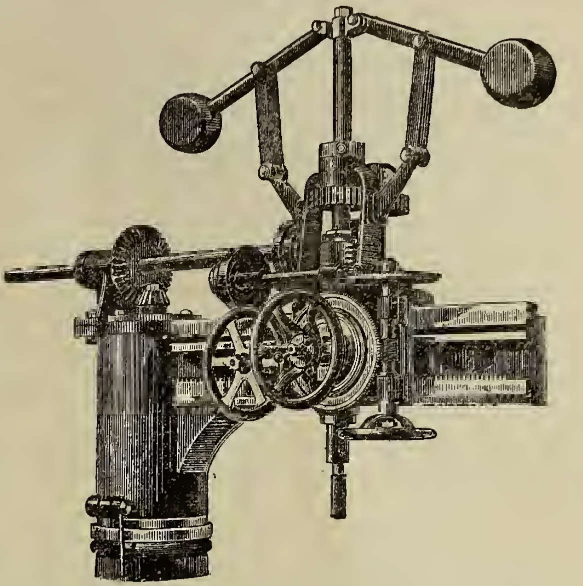
half of the revolution from the lower position to the upper one. The centrifugal force caused by revolution, of course, varies as the square of the speed, and therefore, if the maximum and minimum speeds are, say, as 14 to 11, the centrifugal forces will be as 196 to 121. This means that there will be a downward thrust on the cylinder stud represented by 75 as a maximum. Sideways the machine is in equilibrium, but in the vertical direction it is not, and the force on the cylinder stud will vary at every point in the revolution from a maximum to a minimum. The pressure, however, will always be in one direction, viz., downwards. It is found in practice that this slight want of balance is not near so serious as in the ordinary reciprocating piston high speed engine, as a proof of which, engines on this principle have been driven at as high a speed as 2,000 revolutions per minute without any vibration. One advantage this design possesses is the absence of dead centres, and the engine will therefore start from any position. The turning effort on the driving shaft is also very uniform. For dynamo running this engine is specially adapted, and incandescent lights can be kept absolutely steady without any fly-wheel beyond the action of the engine itself. The engine is enclosed in a box to protect all vital parts, a removable cover being fitted to facilitate lubrication.

The steam ports are four in number, and are presented in turn before a fixed inlet and exhaust. Steam begins to enter the cylinder when the latter is in its lowest position, and is exhausted when in the highest. The governor is enclosed within the main driving pulley, and is connected to an expansion valve which alters the opening of the steam ports only, and does not affect the exhaust opening; in this way the amount of expansion is varied to suit the requirements of the variable load. The engine has a special value for marine purposes, especially in war vessels or cruisers, as the rods for moving the valve can be carried to the bridge and the engine driven by the officer there. It is also well adapted as a winding engine for collieries and mines. The engine may be compounded very simply by merely placing two simple engines on the same shaft.

Rigg's hydraulic engine differs from the above in the manner of valve setting and governing; the former arrangement ensures a full supply of water up to the termination of the stroke, and the latter is effected by altering the eccentricity of the cylinder in relation to the driving shaft, which, of course, alters the length of the stroke of the piston. A supplementary governor is used to effect the alteration, the governor itself having simply to move the valves of the smaller engine. The variable piston stroke ensures that the water used is always an equivalent of the power given out. Altogether Mr. Rigg has succeeded in introducing quite a new type of engine for working with steam or water, which apparently possesses numerous advantages over the ordinary types, and, if realised to the full, will enable the engine to achieve a great success.

Petroleum Fuel for Boilers.—The Chicago *Tribune* reports that the Union Steel Company has decided to use crude petroleum for fuel on a large scale. The oil will be used to fire 36 large boilers It will be fed by gravity from tanks, and applied in a spray in connection with a steam jet. A system of brickwork will protect the boilers, to avoid a repetition of the trouble experienced at the Chicago waterworks, where an experiment with oil fuel resulted in the burning of the boilers.

BALANCED SPINDLE RADIAL DRILL



The particular advantages of the drill shown in our illustration, which is taken from the *American Machinist*, consist in the peculiar method of balancing the spindle with a double weight, thus equalising the strain and preventing side thrust on the spindle, the quick return and automatic feed, and the rapid movement to spindle carriage, through a rack, instead of the usual method by means of a screw. This enables the spindle carriage to be moved along the arm with the facility attending the movement of a lathe carriage; the movement is effected by means of a hand wheel which is on the carriage, and so always in a convenient position, close to where the work is being done, and where the workman must stand, thus avoiding the necessity for going to the end of the arm for that purpose. The hand wheels and clutches for the different movements are conveniently placed for the workman, and it has a locking device to secure the carriage to arm in any position. The illustration represents a drill with a 48in. radius, and having sufficient movement towards the column to cover a great range of work.

PORTABLE HAND-POWER DRILLING MACHINE.

The advantages of portable machines for drilling holes into objects too cumbersome to be taken to the fixed drilling machine are self evident, and need not be dilated upon. The requirements of a good portable drilling machine are fewness and simplicity of parts, without at the same time sacrificing strength, durability, and completeness. Several new features have been introduced into the machine shown in our illustration. In addition to the differential automatic feed motion, there is a hand feed, which will be found very useful for many purposes; and in order to annihilate the friction due to the thrust of the feed, the makers have introduced a roller bearing between the feed nut and the bracket, so that all the work is transmitted to the drill, and is there expended in accomplishing the object in view, and not in slowly rubbing away the feed nut and bracket, a process which is very laborious and expensive. The spindle is of forged steel, and is accurately turned and fitted into unusually long bearings. All the wheels are of malleable cast iron. All the set screws are provided with dies, to prevent damage to the parts gripped. The parts are made interchangeable, so that in case any of them should wear out, the size of the machine and number of the part is all that will be required in ordering a new one. When it is desired, the machine is fitted with powerful gearing, to enable larger holes to be drilled with ease and accuracy. The makers of this machine are Messrs. John Wild and Co., Chadderton, Oldham.

Notice of Removal.—The works of the Frictionless Engine Packing Company are being removed from Wilmslow to more commodious premises in Cable Mills, Glasshouse Street, Oldham Road, Manchester, which will for the future be the firm's only address.

IMPROVED COLLIERY SCREENING APPARATUS.

The depression which has so long prevailed in the coal trade of this country, and the struggle for existence amongst colliery owners against the constantly falling prices, has necessitated the introduction of many different mechanical improvements in the preparation of coal for the markets. The principal gains sought by this step have been of a twofold character: first, a reduction in the cost of labour in the shape of lessened hands, and, secondly, an improvement in the condition of the coal when placed in the market, in the hope of either obtaining higher prices or a more constant supply of orders, so as to enable the pits to work better time. There are other advantages—such as reduction of the breakage of coal in the screening operations to a minimum, a more compact pitstead, and so on—into which it is not necessary that we should here enter. Different districts have had different methods of dealing with their output, according to the peculiarities of the seams of coal worked and of the markets in which the output has to be disposed. In the coking seams of the coal field of the north the proportion of slack produced in either underground or surface operations is of little importance, because slack can, if clean, be converted into coke, and in many districts is ground into dust before being put into ovens. In other districts what are known generally as cobbles may be preferred by some consumers to even large coals, and the same with nuts; but generally speaking, it is necessary to place the coal in the market in as large a form as possible, more especially for house, locomotive, and shipping purposes. In some districts, where the seams of coal worked have contained two, and three, and sometimes four different kinds of coal, they have been filled together in the pit, and sorted by hand on the pit bank, the tubs or corves of coal being passed from one set of men to another to pick out by hand the particular kinds of coal required by them until nothing but small has been left for the last, this being sorted by hand-forks, with bars at necessary intervals, thus leaving the dust, smudge, or smithem, to be filled and dealt with last. This method of banking is, of course, very expensive, and in some cases costs as much as eightpence per ton, or even more. In time fixed screens were introduced, down which the small was tipped to separate the cobbles and nuts from the dust, which would, of course, reduce the cost; and afterwards revolving screens, or perhaps a contrivance by which the winding engine, in raising and lowering the cages in the shaft, conveyed the small coal in some kind of vessel to a higher level, which, when reached, was provided with a contrivance to discharge the contents of the vessel down a long spout, over screens and into wagons. Endless ropes and chains to haul the tubs along the pit banks, close by the wagons, to enable the men to devote the whole of their time to the handpicking process, are also used; but at the best, a seam of coal out of which it is necessary to make so many sorts must of necessity entail considerable expense in properly sorting. Where only two kinds of coal are contained in the seam, say softs and hards, although of each sort many different kinds may be made, the operation of banking may be made very simple, especially if it can be arranged for the men to put the two kinds into distinct corves. Then the pit bank can be divided into two parts, the size of each to be arranged according to the particular requirements of the case, and each sort dealt with in that part of the bank set apart for it. In this case ordinary fixed screens may be made to answer, but by adopting movable screens or shakers, driven from a crank on a shaft passed through the entire length of the pit bank, the small coal will be more effectively separated from the large. Circular revolving screens may also be used in such cases as this, and also the contrivance of raising the slack to a higher level by making use of the winding engine or other machinery that may be conveniently at hand. Of course, in this system it is necessary that the bank levels should be considerably above the wagons, but the great saving in time, and the efficient way in which the work is done, makes it compare very favourably with the primitive method of handsorting wherever it is possible to be put into use. The cost of banking under this arrangement ought not to be more than threepence per ton, whilst under the old handpicking system the coal cannot be put in the market for less than sixpence per ton. In the handpicking system the coal, however, is often better sorted as compared with the usual method of fixed screens, but of late an apparatus has been put into use, in conjunction with fixed or movable screens, known as the travelling band, which gives quite as good results as handpicking, without adding materially, if any, to the cost of labour. Where movable screens are in use, and wherever it is desirable that nut-coal should be produced they are almost necessary, the use of an engine cannot be avoided, and this might very well be used to work the band or belt. The travelling band or belt is made of sheet iron plates the whole width of the band, from 4ft. upwards, and generally about 10in. wide, attached to an endless chain by means of rivets, each plate overlapping at one end with a slight curve, to give room for adapting itself to the different forms through which it has to pass. At either end of the belt is arranged a drum, generally hexagonal in shape, each side being the same length as each link of the endless chain on which the plates are fastened. One of these drums is driven by gearing from the engine in the desired direction, it being much better, the writer finds, to pull the band or belt than drive it with the engine. It is necessary to have, at the opposite end to the engine, a contrivance, generally a screw, to move the drum so as to tighten the band and keep in going order. A travelling band of this description may be used to receive the large coal after it has passed over the screens, or it may be used to convey the coal as it comes out of the pit, to any point within a reasonable distance, before it is passed down the screens; the belt moving slowly, the coal may be picked and dressed, and the large coal prevented from undergoing the risk of breakage in passing down the screens; but much will depend on the circumstances of each case, one way answering well under some conditions, which might under others prove inconvenient; but, generally speaking, it is found best to screen the coal before delivering it on to the travelling band. Of course, several screens may be made to deliver on to the same band, and as many bands must be used in connection with each screen as it is necessary to have sorts well picked before delivery into wagons. The great advantages of travelling bands are, that the coal is well exposed to the view of the banksman, enabling him to properly sort it; the tubs or corves are instantly released; and the belt conveys the coal in the full view of the men to the wagons with a minimum of breakage and at a much less cost than it is possible to do the work efficiently in any other way. Belts may also be used to convey coal in any desired direction, and their numerous advantages have caused them of late to be largely used in most of our principal coalfields.

UNITED STATES GOVERNMENT RULES FOR MARINE BOILER PRESSURES.

II.

RIVETED FLUES.

Flues having a diameter not less than	6″,	7″,	8″,	9″,	10″,	11″,	12″,	13″,	14″,	15″,
and not more than	7″,	8″,	9″,	10″,	11″,	12″,	13″,	14″,	15″,	16″,
shall have a thickness not less than	·18″,	·20″,	·21″,	·21″,	·22″,	·22″,	·23″,	·24″,	·25″,	·27″;

and if in the opinion of the inspectors it is deemed safe may be allowed a steam pressure according to the thickness as follows:

6 to 7 inches in diameter.

Thickness .. ·18, ·19, 20, ·21 of an inch
Pressure in lbs. .. 189, 194, 199, 204 per sq. inch

7 to 8 inches in diameter.

Thickness .. ·20, ·21, ·22, ·23, ·24 of an inch
Pressure in lbs. .. 184, 189, 194, 199, 204 per sq. inch

8 to 9 inches in diameter.

Thickness .. ·21, ·22, ·23, ·24, ·25, ·26 of an inch
Pressure in lbs. .. 179, 184, 189, 194, 199, 204 per sq. inch

9 to 10 inches in diameter.

Thickness .. ·21, ·22. ·23, ·24, ·25, ·26, ·27 of an inch
Pressure in lbs. .. 174, 179, 184, 189, 194, 199, 204 per sq. inch

10 to 11 inches in diameter.

Thickness .. ·22, ·23, ·24, ·25, ·26, ·27, ·28, ·29 of an inch
Pressure in lbs. .. 169, 174, 179, 184, 189, 194, 199, 204 per sq. inch

11 to 12 inches in diameter.

Thickness .. ·22, ·23, ·24, ·25, ·26. ·27, ·28, ·29, ·30 of an inch
Pressure in lbs. .. 164, 169, 174, 179, 184, 189, 194, 199, 204 per sq. inch

12 to 13 inches in diameter.

Thickness .. ·23, ·24, ·25, ·26, ·27, ·28, ·29, ·30, ·31, ·32 of an inch
Pressure in lbs. .. 159, 164, 169, 174, 179, 184, 189, 194, 199, 204 per sq. inch

13 to 14 inches in diameter.

Thickness .. ·24, ·25, ·26, ·27, ·28, ·29, ·30, ·31, ·32, ·33, ·34 of an inch
Pressure in lbs. 154, 159, 164, 169, 174, 179, 184, 189, 194, 199, 204 per sq. inch

14 to 15 inches in diameter.

Thickness .. ·25, ·26, ·27, ·28, ·29, ·30, ·31, ·32, ·33, ·34, ·35 of an inch
Pressure in lbs. 147, 152, 157, 162, 167, 172, 177, 182, 187, 192, 197 per sq. inch

15 to 16 inches in diameter.

Thickness . ·26, ·27, ·28, ·29, ·30, ·31, ·32, ·33, ·34, ·35, ·36 of an inch
Pressure in lbs. 140, 145, 150, 155, 160 165, 170, 175. 180, 185, 190 per sq. inch

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South African Diamonds.—The production of diamonds in British South Africa was very large last year, amounting to 3,646,890¾ carats. The average value of the carat was 22s. 1¼d., so that the gross value of the production of 1887 was £4,033,583.

A NEW LOCOMOTIVE VALVE GEAR.

The Grimes radial valve gear is the invention of a St. Paul machinist. It is, says *The National Car and Locomotive Builder*, in use on several stationary engines about St. Paul, and gives eminent satisfaction. It has been applied to a Brooks mogul locomotive, but has not been in service long enough to demonstrate what it will do, though it promises to do very well. The motion for the valve is taken from a single eccentric. The eccentric strap-rod works upward at right angles to the centre line of motion, and operates a block moving in a slotted link attached to the tumbling shaft. The angle at which the link is set determines the valve travel. By the arrangement, which has remarkably few parts, the valve receives an exceptionally quick motion to open and close.

LUSTRELESS SURFACE ON STEEL.

A finely polished lustreless surface on tempered steel can be procured by either of the following operations. After the steel article has been tempered, it should be rubbed on a smooth iron surface with some pulverised oilstone until it is perfectly smooth and even, then laid upon a sheet of white paper and rubbed back and forth until it acquires a fine dead polish. Any screw holes or depressions in the steel must be cleaned and polished beforehand with a piece of wood and oilstone. This delicate, lustreless surface is quite sensitive, and should be rinsed with pure soft water only. A more durable polish is obtained by first smoothing the steel surface with an iron polisher and some powdered oilstone, carefully washing and rinsing. Then mix in a small vessel some fresh oil and powdered oilstone; dip into this mixture the end of a piece of elder pith, and polish the steel surface with a gentle pressure, cutting off the end of the pith as it commences to become soiled. In conclusion, it should be thoroughly cleansed in soft water, when the article will be found to have a fine, white, lustreless polish.

CORRESPONDENCE.

We do not hold ourselves responsible for the opinions of our Correspondents.

TALLOW CUPS VERSUS SIGHT FEED LUBRICATORS.

To the Editor of "The Practical Engineer."

SIR,—Although the "Sight Feed," or drop by drop process of lubricating steam engines has now become very general, it has often struck me as being very wasteful in the amount of lubricant used, notwithstanding its supposed improvement over the old fashioned tallow cup method, and I think a few figures and a little reflection will convince any disinterested person that such is the case. I have recently indicated a pair of modern tandem engines with 23⅝in. and 44in. cylinders, making 60 revolutions or 600ft. per minute, lubricated in the modern way. Instead of giving the quantity of tallow actually used, as that may vary according to the judgment of attendants, I propose to discuss the principle, and submit a few figures for the consideration of your readers, more especially those who have the charge, and those who have to sustain the cost of working steam engines. Most sight feed lubricators are fixed upon the steam pipe leading to the engine, with the intention of vaporising the lubricant, saturating the steam with the grease, and by means of the greasy steam lubricating the cylinders and other rubbing surfaces. Now, Sir, I contend if the whole of the steam is lubricated or saturated with grease until it can grease the surface of the cylinder and the valve facings, a very large portion of the lubricant must be carried away and wasted in the central body of steam which never comes in contact with the sides of the cylinder at all. If the steam is not so saturated with grease, then rubbing surfaces are not lubricated, and great friction, wear and tear must be the result. For instance, the four cylinders I have mentioned contain upwards of 136 cubic feet of steam. They are filled twice for every revolution of the crank. The engines make 60 revolutions per minute, or one per second. There is therefore (not reckoning clearance) at least 272 cubic feet of steam passing through the engines every second. Now the sight feed lubricator will not discharge more than two or three drops of tallow or oil in that short time, if so much. It does not require much perception to see that two or three drops of oil or tallow, vaporised, and mixed with 272ft. of fresh steam every second, must have very little effect in greasing the surfaces of either valves or pistons. In my opinion it has about as much effect as a glass of gin would have in affecting the taste of a large running river. I consider that nine-tenths, if not all, the grease so sent in with that quantity of steam is absolutely wasted and thrown away. Instead of lubricating the whole of the steam which passes through an engine, even at the risk of being considered either conservative or antiquated, I contend that the old fashioned tallow cup, with its periodical flushings of the lubricant on the surfaces to be lubricated (although liable to great abuse in both directions) is, with proper care and attention, a better method of lubricating a steam engine than the homœopathic system recently come into general use. As the space in your useful little paper is necessarily very limited, and as this letter is in opposition to the orthodox views of the day upon this question, and may therefore provoke adverse criticism, at least from makers and dealers in sight feed lubricators, I reserve further argument in favour of the old tallow cup in preference to the drop by drop system, for a future communication. The large amount of money that may be saved or wasted in these manufacturing districts, by correct or incorrect views upon the subject, must be my apology for submitting these heterodox opinions to your readers.—Yours respectfully,

February 21st. ARTIZO.

THE MIDDLETON JUNCTION ECONOMISER EXPLOSION.

To the Editor of "The Practical Engineer."

SIR,—The explosion of an economiser at the Junction Spinning Co.'s Mill, Chadderton, some six months ago, appears likely to lead to remarkable results in the matter of educating engineers respecting these apparata. In the Board of Trade report on the preliminary inquiry we are told that these apparata are only economisers "so-called," and that the same results in the way of economy may be secured by putting down additional boilers, whilst in your article criticising the Board of Trade report it is stated the economiser, besides being a water heater and purifier, is at the same time a smoke consumer, though not a steam generator. Now, Sir, I have had to do with economisers for something like a quarter of a century, and like M. Jourdain in Moliere's *Bourgeois Gentilhomme*, who was astonished to find that he had been speaking prose all his life without knowing it, I have never been aware either that a Green's economiser was a smoke consumer, or that it was only an economiser in name and not in reality, and that it might be dispensed with if only firms would put down one or more additional boilers instead. I have certainly known cases where large saving in fuel has been effected by putting down a "so-called" economiser, and I was under the impression that one of its principal advantages over an additional boiler was due to the surfaces of the pipes constituting the economiser being regularly scraped and kept clear of soot, etc., which accumulates on the surfaces of the plates of the boilers in a few days, and being a bad conductor materially impairs their efficiency as heating surfaces. It further seemed to me that whereas the plates of a steam boiler, with a temperature approaching, say 300 degs. F., could not absorb a great amount of heat from gases of the same or only a little higher temperature, a much greater gain could be imparted to feed water of say from 60 degs. to 100 degs. in an economiser by the same gases, owing to the very great difference in the two cases between the lower *t* and the higher T. These views, however, may only have been the delusions of an ignorant practical man, and if the officials of the Board of Trade were only permitted to descend from their celestial sphere, and hold converse or parley with ordinary mortals, I should be inclined to ask for some further information, which I presume they must possess, in reference to the folly or impropriety of calling these apparata "economisers." Since, however, this is not permitted, I must perforce content myself with asking you, Mr. Editor, who are always complaisant and ready to answer all kinds of questions put to you by practical men earnestly seeking after information in your columns, to say in what respect a Green's economiser acts as a smoke consumer? Thanking you in anticipation both for inserting this letter and for your reply,—I am, yours, etc.,

Feb. 20th, 1888. A PRACTICAL ENGINEER.

[In the article referred to, the writer evidently made a slip in calling an economiser a "smoke consumer," and possibly had in mind the fact that being a saver of coal, the economiser would also naturally diminish the smoke made, and especially where boilers were hard fired it would reduce the amount of thick black smoke. We are obliged to the author of the above letter for pointing out the error, which at the time had escaped our notice.—ED., *P.E.*]

NON-CONDUCTING COMPOSITIONS.

To the Editor of "The Practical Engineer."

SIR.—In your issue of the 10th February, I was astonished to see the mention of carbonate of magnesia, and 7 to 8 per cent. of asbestos, as a mixture for non-conducting compositions. In the first place, it must be a very costly covering; secondly, it must entail a great amount of labour to make moulds and patterns for every different size of pipe. It might do very well in a land job where there might be a great range of pipes, all of one size; but in marine work it would never do at all, as there are scarcely two pipes of the same length, or the same diameter; and there are bends innumerable. And in marine work men would never get time to measure for templates; it is a hurry up, and as soon as the engineers light fires the coverers must work, day and night, till their work is done. I have seen many kinds of coverings for boilers and steam pipes, and according to an extract from the *Journal of the Society of Chemical Industry*—experiments made by Mr. Emery on non-conducting substances—animal hair is proven to be the best non-conductor. If its non-conductivity is taken as 100, other materials stand in the following order:—Hair, 100; No. 1 slag wool, 67; sawdust, 68; wood-charcoal, 63; deal-wood and loam, 55; asbestos, 36. These figures show to us that asbestos is a poor non-conductor; but I admit of it being a good thing to mix with other substances that are non-conductors, and thereby making them non-combustible. There is a firm in Glasgow who have a composition they call the "Pearl," and by analysis contains two minerals and one animal matter. The results of experiments have proved it to be one of the best non-conductors known. Compared with other compositions of 2in. and 3in. thick, it gives a lower degree of temperature when only 1in. thick; and when damaged can be taken off easily, softened, re-mixed, and put on again, and will be as cool as ever. The results of analysis of this composition are as follows:—Hair, 60·00; silicate, 32·55; magnesia, 2·10: moisture, 1·90; oxides, 2·45; non-combustible, 100·00. With these figures before us I consider that we are perfectly safe against fire with such a covering, even on boilers where 200lbs. per square inch of steam pressure is used, equal to a temperature of 381·07 degrees Fah. and this composition can be put on without skilled labour, whereas if the American style were adopted we should have to employ pattern or model makers.—I am, yours sincerely,

Crosshill, Feb. 11th, 1888. J. COATES, Marine Engineer.

BOILER REGISTRY AND INSPECTION BILL.

To the Editor of "The Practical Engineer."

SIR,—I find in your issue of last week a letter, signed "Public Interest," on the above subject in which he states that a clause (if not already added) ought to be inserted in the Bill to the effect—"That no man can have the charge of engines and boilers without a Board of Trade certificate." I fail to see why a Board of Trade certificate should be required of engine attendants, or, at any rate, in a Boiler Registry Bill. If such a certificate be required, then give the Bill its proper title—Boiler and Engine Registry Bill. There is one question I should like to ask "Public Interest," through your paper, viz., if the Bill passes with the clause before nentioned in it, would he have all enginemen and stokers of twenty years standing, dismissed at once because they do not possess the Board of Trade certificate; or would he consider such a length of service to be a sufficient equivalent.—I am, yours, etc.,

Feb. 20th, 1888. W. B.

POLLITT AND WIGZELL'S ENGINES.

To the Editor of "The Practical Engineer."

SIR,—Replying to "L. R.'s" query, in your issue of the 17th inst., the reason our condensor water is ejected at 120 degs. is that the water is afterwards used for wool washing, and by sending it out at that temperature, little or no steam is required in the wash-house, and the machines are ready for work as soon as the water is run into the bowls, no time being lost in heating up. As to the other points touched upon by "L. R.," they are, after all, matters of opinion. Where doctors differ it is not likely I can throw any light upon the subject; at any rate, I've neither time nor inclination to try.—Yours truly, J. W. J.

Feb. 21st.

LAP JOINTS.

To the Editor of "The Practical Engineer."

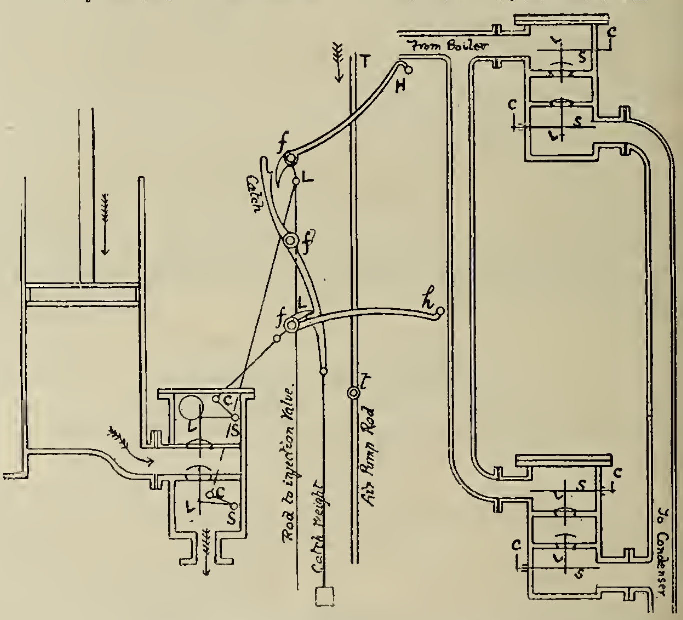
SIR,—I notice Louis F. Griffith's formula for the strength of lap joints, given as a correction of mine, is also an incomplete exposition of the problem, inasmuch as in giving the proportion or dimensions of the different parts of the joint no notice is taken of the minimum breadth to be allowed to the marginal strip between the rivet holes and edge of the plate, as beyond which it cannot be lessened without impairing the strength of the joint. This addition to, and correction of the formula can, of course, be readily applied.—Yours,

Cheetham, Feb. 20th, 1888. W. A.

QUERIES AND REPLIES.

TAPPET MOTION.—Could any correspondent explain, with a sketch, the action of the tappet or plug rod in operating the valves of a Watt's single-acting engine (1769), and his double-actiug engine (1784), through the intermediate mechanism, levers, &c.—A.G.K.

Answer.—First, as to Watt's SINGLE ACTING ENGINE with open top cylinder. Referring to the annexed sketch, which is not drawn to scale, the action of each of the tappets, T *t*, attached to the air pump rod is to move its respective handle or lever H, *h*, round its fixed centre *f*, till its detent lever L *l*, forces back its end of the double ended catch, and is prevented returning by it, by which movement of the handle the valves connected with it are closed, and at the same time a weight (technically called a plunge weight), which is connected by a lever with the handle-shaft, is raised (but to avoid confusion this is not shewn in the sketch), and also by the same movement of the catch the detent lever at its other end, on the same shaft, as the other handle is liberated, when its plunge weight then descends, moving that handle and opening the valves connected therewith. So by the downward movement of the air pump rod the tappet T puts down the handle H, and raises its plunge weight, and the detent lever L passes the catch, which it momentarily forces back, and which as instantly returns and retains hold of the lever L, thus preventing the handle returning to follow its tappet. That movement of the handle closes the exhaust valve, as also the injection valve, which had previously been admitting water to the condenser, and thereby terminates the down stroke of the piston, and the same movement of the catch liberates the detent lever *l*, allowing the lower handle *h* to drop by the action of its plunge weight, thereby opening the steam valve which is connected with it, and so cause the commencement of the up stroke of the piston; on the completion of the up stroke the lower tappet *t* has raised the lower handle *h* till its detent lever *l* is seized and held by the catch. The movement of the handle *h* has closed the steam valve, as well as raised its plunge weight, and thus terminated the up stroke of the piston; by that same movement of the lower handle, and its detent lever *l*, the catch is detached from the lever L, allowing the handle H, by the action of its plunge weight, to open the exhaust and injection valves, and thus commence the down stroke of the piston. This action gives steam pressure and vacuum alternately below the piston, by which its up and down motion is continued.



DOUBLE ACTING ENGINE.—The engine was made double acting by applying a cylinder cover, through which the piston rod could move air and steam tight, and attaching to a nozzle at the top of the cylinder a steam chest with its two valves similar to that below. The same hand-gear served to work the upper valves as those below; the handle H, which works the bottom exhaust valve serves also to work the top steam valve, opening and closing these valves simultaneously; while the handle *h*, which works the bottom steam valve, serves also to work the top exhaust valve, opening and closing these two valves simultaneously. The injection valve in this case is not needed, as a constant stream of water is required in the condenser; and by the action of the hand-gear on the valves the pressure of the steam on one side and vacuum on the other side of the piston is thus given in alternate directions.—W.A.

[P.S.—The left hand sketch shows a sectioual elevation of cylinder, valve chest, and valve gear. The right hand sketch shows sectional elevation of side pipes and valve chests of Watt's double acting cylinder. The centres marked *f* in hand gear and catch are fixed centres round which their respective levers rotate. The valve spindles S are connected by a lever V S with the valve stem, and outside the valve chest with a lever C S by a rod with the hand-gear.

LOAD ON SAFETY VALVE.—Will "T.W." Blackburn, or some other correspondent please say to what pressure the escape valve on pump and safety valve on economiser should be loaded for a pressure in boiler of 100lb.?—T.H.

Answer.—I do not know of any rule for loading feed-water and economiser escape valves; I think in all cases these valves are loaded to suit circumstances, viz., amount of feed required, friction of water in pipes, and temperature to which the water is heated in economisers. I think the majority of escape valves on pumps are loaded about 30lb. higher than boiler pressure. and the economiser safety valve about 10lb. higher, so that it may not blow off until the higher pressure is reached, and thus save the hot water from being blown away. Messrs. Green and Co., might, I think, say something about this, and give us the benefit of their experience.—T.W.

Crossley Air Propellors.—The writer would be glad to know the name and address of the makers of this appliance —G.C.

Answer.—The address of the makers of this propeller is 35, Lever Street Manchester.

Locomotive Tank Engines.—What are the tanks of these engines cleaned with, and why do they prime so furiously on the day after such cleaning?—Shiny Boots.

Answer.—The object in cleaning the tank is to remove the fur, which is done by putting in a quantity of oil with the water. Both are then run out; Yet there still remains sufficient oil on the sides of the tank to cause the water to prime in the boiler, which will continue until no oil whatever exists in the tank.—R.L.F.

Marine Problems.—An engineer once stated that the secret of his success in consumption of coal was owing to the arrangement of his feed pump, part of the water at each stroke being returned to the hotwell. Would this effect any saving of heat, even if successfully carried out, or would the water really remain longer in the hotwell in consequence, though at first sight this would seem to be self-evident?—Q.

Answer.—The engineer spoken of. must, I think, seek some other cause for his success, for a hotwell is not a super-heater, and the longer the feed-water is left in it the colder it gets, as the water heats the hotwell and not the hotwell the water. The second part of the question cannot be satisfacfactorily answered owing to insufficient information being given by "Q.," or perhaps by his informant to him. Everything depends on the method of returning the water. It is, however, difficult to conceive of any apparatus which should regulate automatically the height of the water in the hotwell, and this would be a necessity. A float is out of the question on shipboard, and in ordinary steamers any appreciable head of water is impossible, for marine engineers know too well that as soon as the feed-pumps go wrong the water in the hotwell overflows. Some kind of a reducing valve would have to be designed, which would have on one side of it 1lb. or 2lb. per square inch at most, and at its other side 60lb. or 80lb. at least. In the absence of all description of this apparatus, we may, I think, safely conclude—1st, that the method existed only in the imagination of the successful one, and 2nd, that the success itself was probably a myth.—C.

Wöhler's Experiments.—I should like a formula which will represent the results of Wöhler's experiments on the repetitions of loads. Compare the diameters of the shafts of two engines, the power transmitted and revolutions of each being the same; in one the twisting moment fluctuates between $1\frac{1}{4}$ and $\frac{3}{4}$ the mean, and on the other between twice and $\frac{1}{2}$ the mean.—H.T.

Marine Engines.—Why does the centre line of engines not always coincide with fore and aft centre-line of vessel, as in the case of the *Ormuz*. I presume that it is not the screw shaft that is out of line, but that the engines are inclined a little from the vertical?—Shiny Boots.
one side, and vacuum on the other side of the piston is thus given in alternate directions.—W.A,

Steel Castings.—Would any of your readers give me any information as to the theory of moulding and casting the above? Also if there is any work published on the subject?—Moulder.

Steel Plates.—Will some reader kindly give me a list of lengths and widths of iron and steel plates kept in stock by most merchants. What I want is to be able to design tanks, boilers, &c., without having to get them cut, as this increases the labour, and does not add anything to the strength.—H.L.C.

Cleaning Skylights.—Which is the best way to clean skylights in an engineering works, where soot and dirt collect and stick fast on the glass? What is the best thing to use with water so as to fetch the dirt, &c., off quickly and cheaply.—J.A.

Automatically Closing a Steam Valve.—Can any of your readers inform me of a method for automatically shutting, in a given short time, a steam valve that is opened by a movement which is too quick to be utilized for closing it, and where there is no other motive power available? I have heard that a wing valve would be suitable, but have no knowledge of such a valve, and should be obliged for a description of it, or any other method that would answer my purpose.—Piston.

Brake to Prevent Overwinding.—Could any reader give me a description of the automatic brake to prevent overwinding as used at mines —W.R.

Could any reader inform me how I am to make the following: I want some aluminium tubes about $1\frac{1}{2}$in. diameter, $\frac{1}{16}$in. thick, and about $1\frac{1}{2}$in. long, with flanges on the end. Can I buy the tubes ready made and solder the flanges on, or should I have to get sheet metal, and bend it over, and solder it up all along to make them? What would be the best kind of solder? Is aluminium very expensive, and who manufactures it?—W.Ll.P.W.

Emery Wheels.—Will some one inform me of a good solution for securing emery to an emery wheel?—Constant User.

Copper Cylinders.—Could any reader kindly give me a simple but reliable formula for the collapsing pressures of copper cylinders subjected to external pressure? The dimensions of the cylinders vary from 12in. to 36in. in length, and from 12in. to 36in. in diameter.—Old Finsburian.

TO CORRESPONDENTS,

Fetler.—Messrs. Platt Bros. and Co. Ltd., Oldham, are makers of both cotton and woollen machinery.

J. F.—We believe you will find a description in "Pattern Making," by a "Foreman Pattern Maker."

J.W.J.—On referring again to your letter, we notice that two signatures were used, the second one of which was adopted.

Colliery Pumping Engines.—Snibston Colliery is in Leicestershire. We have not seen any description of these engines.

Adams.—The prices of the specifications are not given in the journal, and hence we cannot insert them in our weekly abstract.

T.W.—Your quickest plan would be to examine a file of *Engineer* or *Engineering*, both of which papers have at different times given dimensioned sketches of Joy's gear.

Constant Reader.—Consult Rigg's "Steam Engine," if you can get to see a copy; also Seaton's work on "Marine Engineering."

Matt.—As far as we are aware there is no book devoted exclusively to this subject, but you will find instructions in such books as Riggs' and Holmes' works on the Steam Engine.

Pollitt and Wigzell's Engines. —We have been requested, by the sender of the diagram of these engines, not to publish them, so that we shall not be able to fulfil our promise of last week.

J.C.—The address of Lloyd's Register of British and Foreign Shipping, is 2, White Lion Court, Cornhill, London, E.C. The various boiler insurance companies, four of whom have their head offices in Manchester, employ the kind of servant you describe. Vacancies are usually advertised in the local papers.

Hydraulic.—You have not sent particulars enough of the arrangement to enable us to answer fully. As far as we can gather, the rams are together when all the water is exhausted, and they are brought together by their respective empty loads, so that the ram with the biggest load will move the one with the least a trifle until there is a balance effected.

J.P.—Cryer and Jordan's book on machine drawing, published at 2/6, and the Lessons appearing in these pages from time to time, will be sufficient exercise for you in drawing. Unwin's book, price 3/6, goes more into the calculations necessary to make a correct design of a machine; for this you would need to know a little of mathematics. Holmes' work on the steam engine would be useful in studying the subject of steam,

Captain of the Three C's.—The low pressure cylinder crank may lead the high pressure one, or it may not according to the designer's fancy. Some engineers prefer it one way, and some the other, There is of course a receiver, or a very large steam pipe, which comes to the same thing, between the cylinders in which the steam is stored until required by the larger cylinder. You can ascertain what changes of pressure take place in the receiver, knowing its relative size, by means of a diagrammatic representation. It is a little puzzling, but a little patience will perhaps enable you to work it out.—"Train mileage" of a company's system simply means the sum of the distance travelled by all the trains in the system. "Engine mileage" is the same as regards the locomotives.

MISCELLANEA.

Preventing Chattering.—A lathe running backward with the tool turned upside down will, it is said, not chatter. A finishing cut might be taken in this way without unscrewing the face plate.

The Electric Light at Bath.—An effort is still being made with the view of introducing the electric light into the city of Bath, and a hope is widely expressed that something practical may be accomplished before the visit of the British Association in September next.

For the third time in ten years a Paris bridge has given way. The Pont d'Arcole was constructed in 1853 to connect the Isle or "Cité" with the Place de l'Hôtel de Ville. On Thursday week large fissures appeared in the paving of the bridge. It is believed that the structure, which consists of a single iron arch, 250ft. wide, and which cost 1,500,000f., will have to be entirely rebuilt.

The Isle of Man Steam Navigation Company, Limited.—It seems that this company is not to be wound up after all. On Saturday Mr. Thompson informed Mr. Justice Kekewich that the company had paid off the debt, and, with the consent of the petitioner, applied that the petition for winding up should be dismissed, the company to pay the petitioner's taxed costs. The application was granted.

Compensation by Railway Companies.—In the past half year the London and North-Western Railway paid for "compensation" close upon £40,000. One-half of the sum was paid for personal injuries, and the other half for loss and injuries to goods. The amounts so paid by the four chief railways of England last half year were as much as £80,000, the Great Western paying least for "personal injuries."

The Electrician's Directory.—We have received a copy of this very useful publication, which has grown very much in size since its first appearance five years ago. The original information given by the Directory has been extended by the addition of several useful tables of scientific and mercantile importance. The biographical section of the book, comprising about 66 pages, has been enlarged, with a corresponding addition to the gallery of portraits, and the latter have also been produced with more care than in former years. The obituary contains notices of Mr. Charles Moseley and Professor Gustav Kirchoff.

Divulging Bank of England Secrets.—Messrs. Portal, of Taverstoke, Hants, the exclusive manufacturers of paper for bank notes and postal orders, applied to Mr. Justice Stirling last week, to prevent the publication of details about the manufacture of the paper. The defendants were Mr. Hine, a former *employé* of Messrs. Portal, and Mr. Catcheside, the editor of a trade paper; and Hine proposed to write an article for Mr. Catcheside's paper, on the manufacture of this special paper. Mr. Justice Stirling granted an injunction until the trial of the action against Mr. Hine, and Mr. Catcheside undertook to deposit Mr. Hine's documents in court.

The Longridge Wire Gun.—A letter from St. Petersburg gives some particulars of the recent trials there of a Longridge 6in. wire gun, weighing about five tons. The following were the results obtained:—

Number of rounds.	Weight of Shot. lbs. English.	Weight of Powder. lbs. English.	Muzzle Velocity. Feet.	Pressure in Gun. Tons per sq. in.
7	72	27 to 38		
19	72	39 5	2,150	19·33
11	90	39·5	1,937	19·37
163	122	39·5	1,715	21·32

A 6in. gun on the same principle has, it is said, been constructed for the English Government, and now awaits trial at Woolwich.

Engineering in Italy.—Speaking of the growth of engineering activity in Italy, a correspondent of the *Engineer* mentions the works of Gio. Ansaldo and Co., and says:—"At present the place is literally congested with work of every description, and it is hard to know what to do first. Besides a quantity of work for manufactories, etc., there are engines of 20,000 H.P. for the *Sicilia*, eight sets triple-expansion engines for the Schichan torpedo boats, three pairs of compound engines of 160 H.P., two of 65 H.P., one of 120 H.P.. two sets of launch engines, sixteen six-coupled locomotives, twenty four-coupled locomotives, seventeen locomotives under repair, ten small boilers, in addition to those above, for the *Regio Marina*, and rudder and tiller gear for five ironclads. This latter is rather a big job by itself."

Wooden Water Pipes.—During the recent excavations in the Strand, opposite Essex-street, for the purpose of laying the Hydraulic Power Company's mains, about 40ft. of old wooden water-pipe was unearthed. It would seem that they date from the introduction of the New River water, for which we are indebted to the perseverance and public spirit of Sir Hugh Myddleton, ably seconded by King James I., who agreed to pay one-half the expenses, in consideration of one-half share in the ultimate profits, and to repay Myddleton one-half of what he had already disbursed. The pipes laid down for the conveyance of the New River water are said to have passed through the streets to the extent of 400 miles. The pipes were formed of small elm trees, drilled through the centre, and cut into lengths of about 6ft., one end being tapered to fit into the one laid before it. These pipes are said to have leaked and burst during the frost.—*Engineer.*

The First Persian Railway.—The construction of the first Persian railway is already begun. The line is to extend from Resht, on the southern shore of the Caspian, to Teheran. The distance as the crow flies is about 150 miles, but since the railway has to cross the Elburz range of mountains, it must have a much greater length than that. The work has been placed in the hands of a Belgian syndicate. The engineers are on the spot, and materials are arriving from Europe. Both the Shah and the Russian Government are urging forward the enterprise very energetically. The labourers employed are chiefly from Southern Russia, but some of them are Asiatics who have previously been engaged in making the Russian line to Merv. No intention exists at present of extending the line beyond Teheran, but there are schemes for eventually carrying it eastward to Meshed, and perhaps Herat, if not to India, and southward to the Persian Gulf.

Engineering Society, King's College London.—At a general meeting of this society, held on Tuesday. February 21st, the president. Mr. Gask, in the chair, a paper was read by Mr. Jones on "Cable Tramways." The author commenced his remarks by giving a short history of cable tramways as first introduced in America. He then went on to describe fully the Highgate line. The track consists of a trench formed by two steel -Z shaped girders, which nearly meet at the top, leaving a slot $\frac{5}{8}$in. wide, through which the gripper passes; the whole is set in concrete; pullies are placed at intervals of 40ft. for the cable to travel on. The cable is made of the best crucible steel wire, 3in. in circumference. The gripper consists of two plates, each having a jaw at the bottom; the plate carrying the upper jaw is fixed to the car, while the other can slide up and down, and so grip the cable. The author then described the several methods adopted on different lines for going round curves. A working model consisting of the car and line of the Patent Cable Tramway Corporation was shown, also models of grippers of the Clay-street, Sutter-street and Highgate lines. In the discussion which followed. Mr. Colam said the wear of the cable was very great; the gripper was generally placed too high above the pullies. The universal form of gripper adopted in America was with the upper jaw moveable and the lower fixed, consequently while the car was at rest, the cable was constantly wearing on the lower jaw; he held that the lower jaw ought to be the moveable one, and when the car was at rest to be lowered, so that the cable did not rub. He said that pullies 48ft. apart had been used on the Edinburgh line and had been found quite sufficient. Mr. Sparks gave some particulars of the vacuum brake used in New York. Mr. Gask and Mr. Hewett also spoke, and the meeing adjourned after the usual vote of thanks.

Iron as a Heat Conductor: Forbes' Experiments.—The capacity of iron for conducting heat decreases as its temperature increases. But according to a paper contributed to the Royal Society of Edinburgh, by Mr. A. Critchton Mitchell, and about to be published in the society's *Transactions*, that is an error. The result of Mr. Crichton Mitchell's experiments show that iron does not differ, as regards conductivity of heat, from other metals.

SELECTED PATENTS.

APPLICATIONS FOR LETTERS PATENTS.

February 10th.

2002 Electrical Tool, T. Thorp, Whitefield.
2005 Shaft Guard, W. H. Stopford, Oldham.
2008 Railway Signalling, H. Morris, Manchester.
2009 Belt Fasteners, J. S. Crowley, Manchester.
2013 Oil Cans, G. Cole, Stourport.
2015 Semaphore Signalling Apparatus, J. B. Hannay, Glasgow.
2016 Plates for Furnaces and Combustion Chambers, J. Rankine, J. P. Hall, and R. Falconer, Durham.
2017 Cranes, J. Gaskell, Longport.
2018 Armour Plates, J. C. Bothams, Salisbury.
2019 Disintegrating Copper Pyrites, J. Perino, London.
2022 Preventing Overwinding in Winding Engines, J. Frew, Glasgow.
2024 Furnace and Flue-Tubes, J. H. Tordoff, Leeds.
2032 Miners' Tools, R. L. Muir, Glasgow.
2034 Pulleys and Drums, G. G. Cotsworth, London.
2038 Punching Tool, A. Buchanan, London.
2042 Guards for Pulleys, Wheels, &c., M. A. Brigg, London.
2047 Horticultural Boilers, John Watson, London.
2050 Refrigerating Apparatus, J. P. Lawrence, London.
2055 Boiler Furnaces, E. Jolibois and W. V. Bonsor, London,
2064 Aautomatic Brake Mechanism, A. P. Kapteyn, London.

February 11th.

2076 Friction Pulleys, J. W. Hearfield, Hull.
2078 Hot Air for Boilers, W. Schofield, Oldham.
2080 Rotary Engines, J. Robinson, A. J. Ash, and J. Robinson, Birmingham
2081 Automatic Saw Sharpener, J. Hill and I. Hill, Derby.
2088 Dynamometers J. G. Gilchrist, Glasgow.
2090 Obtaining Power from Railway Trains, J. Gibson, Paisley.
2094 Shaft Couplings, C. F. Cockshot and J. E. Jowett, Bradford.
2096 Manufacture of Illuminating Gas, J. H. R. Dinsmore, Liverpool.
2100 Type Writing Machines, J. Hutchison, Glasgow.
2107 Tool for Extracting Broken Screws, E. B. Whatley and R. Partridge, London.
2112 Blast-Pipes. H. Appleby, London.
2114 Double Engine Ploughing, R. Katz. London.
2116 Shaft Couplings, J. S. Raworth, London,
2118 Shears for Metal, W. J. Bayrer. London.
2119 Lubricator, J. C. Nicol, London.
2121 Coupling for Railway Waggons, A. Barter, London.
2124 Steam and Vacuum Pumps, E. Hodgkin and P. E. Hodgkin, London.

February 13th.

2133 Working Cranes by Compressed Air, J. Sturgeon, Birmingham.
2149 Cocks for Engine Indicators, T. S. McInnes, W. France, and R. Morgan. Glasgow.
2150 Testing Spiral Springs, T. S. McInnes, Glasgow.
2160 Heating of Railway Carriages, G. S. Watson, London,
2165 Thrashing Machines, J. Marshall, London.
2167 Points for Tramways. J. Kincaid, London.
2172 Drills for Rock Tunnelling, H. N. Penrice, Middlesex.

February 14th.

2197 Connections for Flexible Piping, P. C. Lawless, Glasgow.
2200 Gas-producers, T. Williamson, Rutherglen.
2203 Cartridge Charges for Machine Guns, R. Evans, Newcastle-on-Tyne.
2204 Excavators, J. H. Simpson and S. Porter, Liverpool.
2208 Plates for Straining Pulp, J. Scott. Glasgow.
2212 Prevention of Corrosion and Pitting in Propellers, W. C. Wallace, and R. D. Smillie, Dumbarton.
2215 Steam Engines and Pumps, G. W. Newall, Manor Park.
2216 Car Axle Boxes, H. L. Moyer and G. W. Youlls, Washington.
2218 Compasses and Calipers, J. Stevens London.
2222 Bow-compasses, J. A. Butterworth, London.
2223 Combination Tools, R. Elliott, London.
2234 Car Axle Lubricators, W. H. Wheatley, Middlesex. (R. Faas, United States.)
2238 Weighing Machines, W. Snelgrove, London,
2247 Copper-plate Printing Machines, J. Larivière, London.
2252 Duplex Pumps, O. Imray London. (J. Dow, United States.)

February 15th.

2263 Holders for Cutting Tools, W. Bashall and W. J. Box, London.
2267 Copying Lathes, W. Smith, Birmingham.
2268 Fans for Exhausting Air, J. Crighton, R. Crighton, and G. C. Peel, Manchester.
2269 Fans for Exhausting and Propelling Air, J. Crighton, R. Crighton and G. C. Peel, Manchester.
2271 Steam or Gas Engines, H. Bleasdale and F. Hargreaves, Manchester,
2278 Boiler Feeding Apparatus, W. Schmidt, Berlin
2279 Boring Machines, G. W. Elliott, Sheffield.
2283 Steam-Engines, H. Liversidge, Junior, London.
2286 Thrashing Machines, T. Bee, London.
2225 Turning and Screw Cutting Shafts, T. Hunt, London.
2301 Expansion Gear for Steam Engines, H. Muncaster, London.

February 16th

2319 Riveting Machines. J. Morton, Birmingham
2342 Furnace Boilers, C. J. Henderson, Hawick.
2358 Railway Rails, S. Simmins, London.
2363 Gearing for Transmitting Power, C. J. Came, Middlesex.
2366 Manufacture of Cement, G. J. Snelus, J. C. Swan and H. Smith, London.

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EDITORIAL NOTICES.

All communications for the Editor of this Journal should be addressed to 6, Victoria Station Approach, Manchester.

Communications intended for insertion in the current week's issue should reach us not later than Tuesday Evening.

We cannot undertake to return rejected manuscripts or drawings unless accompanied by a stamped and directed envelope.

Contributors are requested to write on one side only of the paper. Sketches should be sent on separate sheets.

TO ADVERTISERS.

Advertisements intended for insertion in the current issue should reach us on Wednesday morning at the latest.

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NOTICE TO NEWSAGENTS AND SUBSCRIBERS.

Numerous complaints having been made to us by Subscribers of the difficulty they experience in obtaining copies of the *Practical Engineer* in certain districts, we have to state that the Journal can be obtained by any Newsagent through the ordinary trade channels, and no difficulty should therefore exist in obtaining copies by order of any Newsagent.

For the information of the trade, we may state that copies can be obtained from either of our Offices in London or Manchester, or from any of the following wholesale houses, who are also supplied with Contents Bills for the use of the trade:—

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W. H. SMITH & SON, Blackfriars Street, Manchester.
JOHN HEYWOOD, Deansgate, Manchester.
ABEL HEYWOOD & SON, Oldham Street, Manchester.
J. MENZIES & CO., Hanover Street, Edinburgh.
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EDWARD KING, 37, Greyfriars Lane, Coventry.
&c., &c., &c.

Important Notice to Newsagents and Subscribers.

Our Publishing Offices in London are now at 11, PATERNOSTER BUILDINGS, E.C., where the Trade will in future be supplied.

Simultaneously with the above change, our PUBLISHING OFFICES in MANCHESTER have been REMOVED from Grosvenor Chambers, Deansgate, to more commodious and convenient premises at 6, VICTORIA STATION APPROACH, where all communications intended for the Manager or Editor should, in future, be addressed.

IRISH INDUSTRIAL ENTERPRISE.

AMONG the greatest economic problems of the present day are the development of new and profitable industries and the finding of fresh markets for our productions. The depressed trade in England of the past ten years has largely been due to two causes: the increased and cheapened means of communication between all parts of the globe, and the increased development of foreign competition, owing to the general freedom from war that has existed among the great nations, who have thus been enabled to give full attention to industrial progress.

In none of our industries has foreign competition been so severely felt as in that of agriculture, the augmented facilities for communication having practically destroyed our grain cultivation and seriously diminished the profits on all produce that is capable of being brought from a distance without suffering in quality.

Nowhere has this competition been more felt than it has been in Ireland, and no doubt this is at the root of much of the poverty and discontent that so largely prevails in the sister isle. Wheat is only grown there to one-fourth the extent that it was twenty years ago. Butter and eggs, that once were supplied from Ireland, are now brought to this country from Normandy, Holland, and Denmark; pork, bacon, and beef are imported from the United States and Canada instead of from Ireland; and similarly through the whole range of agricultural production, except that of breeding cavalry horses and hunters.

Can this deplorable poverty of Ireland be remedied? We believe it can to some, indeed to a great extent, as there are, undoubtedly, great sources of undeveloped wealth in Ireland and its surroundings. A visit to the Irish Section of the Manchester Jubilee Exhibition was an education in itself on this matter. There are great but undeveloped sources of employment and gain in Irish fisheries, both in fresh water and deep sea, but these require quick transit to market, and the means for this are absent from those parts of the country which would derive the greatest benefit therefrom.

We understand that the Government have decided to assist the construction of several single lines of railway in the West of Ireland, lines which cannot possibly pay dividends for many years, but which will bring Irish produce within the reach of English markets, and open out communication and means of employment in the most poverty-stricken districts.

Let us examine for a moment the state of things existing in one of these districts of which we have a personal knowledge. The Commission have reported favourably to the Government on the construction of a single line of railway from Ballina to Belmullet, a small port in the county of Mayo. The line passes through 42 miles of country which is more or less barren moorland, but yet there is a large though scattered population along the route, and Belmullet itself stands on the only outlet from the Mullet, a peninsula, almost an island, about 20 miles long by 4 miles wide. The cost of carriage of goods between the termini of the proposed new line is about £2 per ton, and cattle are driven by road to Ballina, the terminus of the Midland Great Western Railway, taking three days for the journey, and, of course, losing weight on the way.

Broad Haven, Black Sod Bay, and the open Atlantic teem with valuable fish, but as there are no means of getting it to a market there is no fishing. The rivers are full of fine salmon, but the delay and cost of conveyance are much against the trade. There have been many attempts at copper and lead mining on the lodes which exist in this district, but the difficulties of transit are so great that the mines have, one by one, been abandoned. The conveyance of all this, added to the fall in price of all agricultural productions is utter, irredeemable poverty. The peasantry live by the cultivation of their potato patches, and if the crop fails they must either be assisted or they starve, and, at the best, they are compulsorily idle for three-fourths of the year.

On Saturday last, at a meeting which was held at the Grand Hotel, Manchester, a project was initiated for the development and working of the Granite Quarries at Termon, in Black Sod Bay, situate on the Mullet, perhaps the poorest district in the whole of Ireland. The meeting was a very successful one, and much support was promised for the undertaking. Amongst those present were Messrs. Nicholson and Mottram, the lessees of the quarries; Mr. Michael Davitt; Councillors Southern, Hutt, and Gunson, of Manchester; Mr. W. Ingham, M.I.M.E., Mr. W. Hollingworth, M.E., F.G.S., who (as well as Mr. Gunson, C.E.) has inspected and reported on the quarries; and Messrs. Smethurst, Ryecroft, Lockwood, Underwood, and others. A general opinion prevailed that the working of the quarries would result in a great financial success, as the quality of the stone and the facilities for working and shipment are so great, besides being of great benefit to the large unemployed population of the district. Mr. Davitt stated that the people of the Mullet are the most peaceable and industrious in Ireland; that there is not a single branch of the National League in the district; and promised on behalf of the people that the company should not only not be boycotted, but heartily welcomed into the district.

We purpose alluding to some of the principal features of the quarries and district in a future issue, and, meanwhile, wish the company every success in their industrial enterprise.

NOTES.

It will be interesting to note what effect the recent transference of Lord Stanley from the office of President of the Board of Trade to the post of Governor-General of Canada will have upon the question of Boiler legislation. It will be remembered that when the bill dealing with this subject was presented to the House of Lords last year Lord Stanley consented to its withdrawal, on the understanding that a Select Committee should be appointed this session to consider the whole question, and it will be curious to note whether Sir Michael Hicks-Beach will fulfil the promise of his predecessor, or whether the whole subject will now be allowed to fall to the ground.

The Iron and Steel Institute's visit to America has been postponed on account of the Presidential election, which will take place next autumn. The iron and steel masters of the States have urged the desirability of this course, inasmuch as the election will be of absorbing interest on account of the proposed tariff reduction. Another place will, therefore, have to be selected for this year's autumnal meeting.

The exhibitors at the forthcoming Brussels Exhibition met last week, in London, at the invitation of the Lord Mayor, to appoint someone to act on their behalf as a body, so as to obtain all the privileges granted by the railways and Custom House to native exhibitors. Mr. Lee Bapty, the manager of the Manchester Exhibition, was unanimously appointed official representative. The whole of the space in the English Section of the Exhibition has been applied for.

The American chilled wheels for railway passenger service are, according to some figures given in a recent discussion at the New England Railway Club, not giving anything like satisfaction. The annual failure of these wheels on the Pennsylvanian line is stated to be 1 in 250, as compared with 1 in 10,000 of the steel-tyred wheels on the English railways. On the Lake Erie and Western 18,000 wheels out of 300,000 in use had to be removed in one year. Notwithstanding the heavier loads, greater variation of temperature, and rougher permanent way in America as compared with this country, the enormous number of failures can hardly be accounted for except on the theory that the wheel is bad in principle. At any rate, its performances came far short of the steel-tyred wheels common on English railways.

Messrs. A. C. Wells and Co., Ardwick, Manchester, have brought out, after many years' working, a new oil lamp called the Wells' light. The lamp is portable, and can be swung up to any height and moved about easily, and a power of from 2,000 to 2,500 candles can be obtained at a cost, it is said, of 3d. per hour. The oil is supplied to the burner under pressure, by means of compressed air, forced with a hand pump, and it will work several hours without attention. We understand the Manchester Ship Canal contractors have given a large order for this lamp, to be used on all their workings.

The sixty-third annual report of the Steam-engine Makers' Society has just been issued, and shows an income for the year 1887 of £14,838 and an expenditure of £14,266, leaving a balance, with what was brought forward from the previous year, of £10,229, equal to just over £2 per member. The Bolton strike cost the society £2,500. The sum of £1,714 has been paid to superannuated members, £2,729 to sick members, and £745 to funeral benefits. At present the outlook is considered good; men are in demand, and their liabilities are decreasing.

SOME PRACTICAL NOTES ON MARINE ENGINEERING.—XI.

(*Continued from page 16.*)

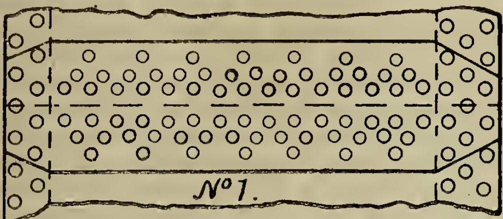
In continuation of our articles on this subject we propose to proceed with some remarks on the design of boilers, confining ourselves to those of the cylindrical multitubular type, as represented in former sketches.

Notwithstanding the difficulties to be overcome in the manufacture of this class of boiler for the high pressure of the modern marine engine, it is a noteworthy fact that no other kind of boiler has been successfully adopted, and at the same time there is no patent boiler of any other type fitted on board an ocean-going steamer. Improvements in design and manufacture have placed the ordinary cylindrical boiler with flat ends in the favourable position it now holds with engineers. The principal obstacle to be mastered has always been the furnace, and this has now been, to a large extent, overcome by the introduction of flues on the corrugated or other similar plans. The improvements in the style of riveting adopted in the longitudinal seams, whereby a large percentage of joint is retained, has tended to reduce the thickness of shell plate; and as this joint is one of the most important in the boiler, we propose to give a short description of its design.

It is now generally known and well understood that, excepting the spherical, the cylindrical form is the strongest that can be adopted to withstand internal pressures, and as the difficulties to be overcome in securing this form are more or less those dealing with the magnitude of the work in hand, that is the weight and size of the plates, they have been easily overcome. The shell longitudinal joint is a matter of the greatest importance, and we see, on reference to the sketches Nos. 1 to 5, what a much larger percentage is retained than used to be the case with the lap joint of iron boilers, and even when the double butt straps were used the percentages of joint wore much less than those found in every-day practice at the present time.

The various kind of joints in use may be classified as follows:—

Double butt strap..	Three rows of rivets..........	Five rivets to one pitch..	No. 1
,, ,, ,, ..	,, ,, ,, ...	Four ,, ,, ,, ..	,, 2
,, ,, ,, ..	,, or more rows of rivets ..	Equal pitch each row ..	,, 3
,, ,, ,, ..	Two rows of rivets..........	Three rivets to one pitch	,, 4
,, ,, ,, ..	,, ,, ,, ...	Equal pitch each row....	
Lap joint	Three ,, ,, ...	Four rivets to one pitch..	,, 5
,, ,, ...	,, ,, ,, ...	Equal pitch each row....	
,, ,, ...	Two ,, ,, ...	,, ,, ,, ,,	
,, ,, ...	One row ,, ...		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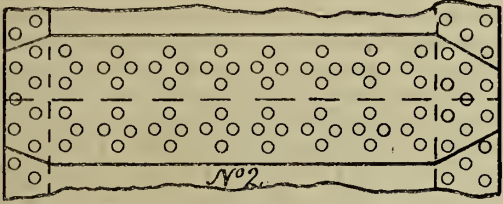
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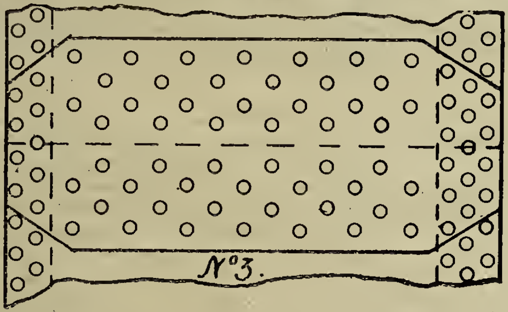
The distribution of rivets near the circumferential seam varies according to the length of boiler, and each case must therefore be made to suit. The thickness of butt strap should never be less than ·75 times that of shell plate, and the diameter of rivet not less than the thickness of plate; but when the rivets are in this proportion the thickness of the outside strap may be advantageously increased to ·8 times thickness of the shell, so as to get a good caulking edge.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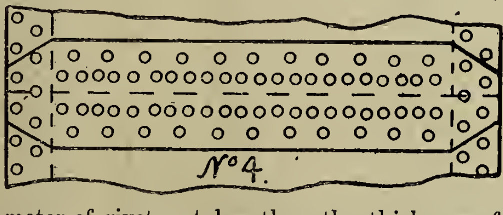
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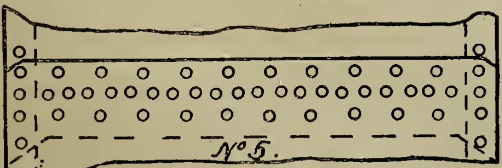

No. 5.

Investigating the different sections of the butt joint, it will be seen that the plate may shear between the outside row of rivets; this is the plate section, and is generally known as the percentage of plate. Next, the plate may shear between the inner row, and also shear the outside rivets; or again, it may shear all the rivets in one half of the butt strap; the latter is called the percentage of rivets, that is, as compared with the solid plate. The butt straps may shear through the centre, but they are always of a combined larger section than the plate itself.

Independent of the thickness of the plate, the pitch for a required percentage is regulated in proportion to the diameter of rivet, and in the following table the diameter of the rivets and pitches are given from 80 to 86 per cent of plate, and is in accordance with the usual practice.

Dia. of Rvt.	Area of Rivet. Square inches.	Value of one rivet Double shear.	Value of one rivet Single shear Lap joint.	80 per cent. Pitch.	81 per cent. Pitch.	82 per cent. Pitch.	83 per cent. Pitch.	84 per cent. Pitch.	85 per cent. Pitch.	86 per cent. Pitch
$\frac{5}{8}$	·3	·446	·255	$3\frac{1}{8}$	$3\frac{5}{16}$	$3\frac{1}{2}$	$3\frac{11}{16}$	$3\frac{15}{16}$	$4\frac{3}{16}$	$4\frac{7}{16}$
$\frac{11}{16}$	·3712	·5519	·315	$3\frac{7}{16}$	$3\frac{9}{16}$	$3\frac{13}{16}$	$4\frac{1}{16}$	$4\frac{5}{16}$	$4\frac{9}{16}$	$4\frac{15}{16}$
$\frac{3}{4}$	·4417	·654	·375	$3\frac{3}{4}$	$3\frac{15}{16}$	$4\frac{3}{16}$	$4\frac{7}{16}$	$4\frac{11}{16}$	5	$5\frac{3}{8}$
$\frac{13}{16}$	·5185	·771	·44	$4\frac{1}{16}$	$4\frac{5}{16}$	$4\frac{1}{2}$	$4\frac{13}{16}$	$5\frac{1}{16}$	$5\frac{7}{16}$	$5\frac{13}{16}$
$\frac{7}{8}$	·6	·892	·51	$4\frac{3}{8}$	$4\frac{5}{8}$	$4\frac{7}{8}$	$5\frac{3}{16}$	$5\frac{7}{16}$	$5\frac{13}{16}$	$6\frac{1}{4}$
$\frac{15}{16}$	·69	1·02	·586	$4\frac{11}{16}$	$4\frac{15}{16}$	$5\frac{3}{16}$	$5\frac{9}{16}$	$5\frac{7}{8}$	$6\frac{1}{4}$	$6\frac{11}{16}$
1	·7854	1·167	·667	5	$5\frac{1}{4}$	$5\frac{9}{16}$	$5\frac{15}{16}$	$6\frac{1}{4}$	$6\frac{11}{16}$	$7\frac{1}{8}$
$1\frac{1}{16}$	·89	1·318	·756	$5\frac{5}{16}$	$5\frac{5}{8}$	$5\frac{15}{16}$	$6\frac{1}{4}$	$6\frac{5}{8}$	$7\frac{1}{16}$	$7\frac{5}{8}$
$1\frac{1}{8}$	·994	1·478	·844	$5\frac{5}{8}$	$5\frac{15}{16}$	$6\frac{1}{4}$	$6\frac{5}{8}$	7	$7\frac{1}{2}$	$8\frac{1}{16}$
$1\frac{3}{16}$	1·11	1·65	·943	$5\frac{15}{16}$	$6\frac{1}{4}$	$6\frac{5}{8}$	7	$7\frac{7}{16}$	$7\frac{15}{16}$	$8\frac{1}{2}$
$1\frac{1}{4}$	1·227	1·824	1·04	$6\frac{1}{4}$	$6\frac{5}{8}$	$6\frac{15}{16}$	$7\frac{3}{8}$	$7\frac{13}{16}$	$8\frac{5}{16}$	$8\frac{15}{16}$
$1\frac{5}{16}$	1·35	2·	1·14	$6\frac{9}{16}$	$6\frac{15}{16}$	$7\frac{5}{16}$	$7\frac{3}{4}$	$8\frac{3}{16}$	$8\frac{3}{4}$	$9\frac{3}{4}$
$1\frac{3}{8}$	1·484	2·2	1·26	$6\frac{7}{8}$	$7\frac{1}{4}$	$7\frac{5}{8}$	$8\frac{1}{8}$	$8\frac{5}{8}$	$9\frac{3}{16}$	$9\frac{13}{16}$
$1\frac{7}{16}$	1·62	2·4	1·37	$7\frac{3}{16}$	$7\frac{9}{16}$	8	$8\frac{1}{2}$	9	$9\frac{9}{16}$	10

The diameter of rivet is always more than the thickness of plate, except in thick plates, say $1\frac{1}{8}$ and upwards, when they are sometimes of the same diameter as the thickness of plate.

The number of rivets to a pitch is such that their combined effective area is equal to the area of plate between the outside row, and is calculated as follows: For joints as shown in sketches having rivets in double shear—thickness of plate × pitch less diameter of rivet, or thickness × pitch × percentage of joint = 1·75 area of one rivet × number of rivets to a pitch × ·85.

The rivet area is usually more than the plate area. The value of one steel rivet in a butt strap (double shear) is shown in the third column of the table. The value of a steel rivet in a lap joint (single shear) is shown in column 4. For iron rivets in steel plates × by ·7 instead of ·85. The pitches in table also refer to lap joints, but the rivet area for equal section with plate will be: Area of one rivet × number of rivets to a pitch × by ·85 for steel rivets, and by ·7 for iron rivets in steel plates. All holes should be drilled.

Example.—Take $1\frac{1}{8}$ rivets, 84 per cent = 7in. pitch. Suppose the plate to be $\frac{15}{16}$ thick, then $7 \times \frac{15}{16} \times {\cdot}84 = 5{\cdot}5$ sq. inches of section. Each $1\frac{1}{8}$ rivet = 1·478 sq. in., then $\frac{5{\cdot}5}{1{\cdot}478} = 3{\cdot}7$ rivets, or say 4 rivets to a pitch will be in favour of the rivet area. If the plate had been $1\frac{1}{16}$in. thick, it would have required a little more area than there is in 4 rivets $1\frac{1}{8}$ dia., as $\frac{7 \times 1\frac{1}{16} \times {\cdot}84}{1{\cdot}478} = 4{\cdot}2$ rivets; but if the plate had been 1in. thick, 4 rivets to a pitch would have been sufficient, as $\frac{7 \times 1 \times {\cdot}84}{1{\cdot}478} = 3{\cdot}97$.

The working pressure is calculated thus—

$$\frac{S \times \text{percentage of joint} \times 2T}{D \times f} = WP.$$

Where S = strength of material = for steel 28 tons = 62700lb. per square inch.
,, % = percentage of joint, as already explained.
,, T = thickness of shell plate in inches.
,, f = factor of safety, see following table.
,, D = mean internal diameter of boiler.
,, WP = Working pressure.

According to Lloyd's rules, the factor of safety varies with the thickness of plate within certain limits, approximately as follows, but with the difference that Lloyd only takes four stages instead of advancing by each $\frac{1}{16}$in. in thickness.

Thickness.	Factor of Safety.	
	Butt Joint.	Lap Joint.
$\frac{6}{16}$	5·8	6·27
$\frac{7}{16}$	5·63	6·1
$\frac{8}{16}$	5·47	5·9
$\frac{9}{16}$	5·32	5·75
$\frac{10}{16}$	5·18	5·6
$\frac{11}{16}$	5·	5·4
$\frac{12}{16}$	4·9	5·28
$\frac{13}{16}$ and above	4·82	5·2

The increase in the factor of safety, as the plates get less in thickness, is to retain a more uniform factor in case of internal corrosion or general wasting of the plates; thus $\frac{1}{16}$ corroding off a $\frac{1}{2}$in. plate is $\frac{1}{8}$ or 12·5 per cent total reduction of sectional area, while $\frac{1}{16}$ off a $\frac{3}{4}$ plate is $\frac{1}{12}$ or 8·3 per cent total reduction.

As nearly all marine boilers are made to the requirements of either Lloyd's or the Board of Trade, the rules of one of these institutions will be referred to where necessary.

LESSONS IN MECHANICAL DRAWING.—XIII.

By Prof. A. MacLay, B.Sc., C.E.

ON DRAWING CURVES FROM EXPERIMENTAL DATA.

The two variable but mutually dependent elements referred to in the last lesson may be correlative quantities of any kind. Among those most frequently represented by diagram are such as stress and strain; pressure and volume; motion and resistance; composition and strength; capacity and production. Let us take for example a stress and strain diagram. It does not lie within the province of these lessons to explain how the figures supplied as data in such cases are obtained. For our present purpose it is only necessary to explain what they mean.

In these diagrams the one set of co-ordinate distances represents the stresses or resistances offered by a test piece of any material under a gradually increasing load; the other the strains or alterations of size or shape which are the results of these stresses. The stresses are measured by the amount of the load pressure or force applied; the strains by the extent of the alteration produced. Both may be of different kinds, but as quantitative results they can always be represented by lines in the one way, these lines being made proportional in length to the numerical values to be represented. The stresses are expressed in terms of weight—in lbs., in cwts., or tons, or of moment—in foot lbs. or inch tons; and the strains in terms of linear or angular measurement—in inches or degrees, and small fractions of these.

Expressed in these units, it generally happens that the numerical values of the strains are very small as compared with those of the stresses; hence it is seldom that the one scale is suitable for both sets of co-ordinates. The choice of scales depends upon the degree of accuracy with which we wish the results to be represented. The diagonal method (which was explained and illustrated in Lessons VI. and VII., pp. 479 and 505 of Vol. I.) readily lends itself to the necessities of the case for minute measurements, as will be seen in the example which follows. When the diagram is not limited by the size of a page, like fig. 72, 1in. per ton forms a very convenient scale for the loads, as measurements can be very accurately made to the hundredth part of a ton, a quantity sufficiently exact for most experiments on metals. In the case of the strains, they may sometimes be represented by the actual dimensions, but more frequently they have to be magnified, at least in the earlier stages of an experiment.

After having obtained the required lengths from suitable scales, the next step is to measure off one set of co-ordinate distances along each axis from the "origin," as the intersection of the axes is called. Perpendiculars drawn to the axes from each pair of corresponding points will meet in a series of points, through which is to be drawn the curve of results required. This curve shows in a very striking way the relation of the two factors in the product, viz., the manner in which the strain varies with the stress. It is immaterial, so far as the form of the curve of results is concerned, which set of co-ordinates is used for the stresses and which for the strains. But the horizontal axis OX in a diagram is naturally a more convenient datum line than the vertical axis OY. We therefore measure the stresses from (*i.e.*, perpendicular to) OX, and the strains from OY, when we wish to make the variation in the stress the chief feature in the diagram, as in fig. 75 (next lesson), and *vice versa*, when the variation in the strain is the characteristic to be brought into prominence, as in fig. 72. In the former case, we may call the curve a "stress curve," or "curve of resistance;" in the latter, a "strain curve," or "curve of deformation."

Of both stress curves and strain curves, two may be required in any diagram. For the stress curve may be (1) a curve of resistance per unit of original sectional area of the test piece; or (2) per unit of actual sectional area at each stage of the experiment; the one representing the ordinary tensile strength the other, the ultimate cohesive strength of the material, as shown in fig. 75 from Table VI. And the strain curve may represent (1) the amount of elastic or temporary strain (that shown while the load is still on); or (2) the residual strain or permanent set (the alteration remaining after the load has been removed), as shown in fig. 72 from Table I.

For example: Let it be required to draw the curves representing the figures given in the following table, which is a synopsis of results of experiments on cast-iron bars, 10ft. long by 1in. square in tension.

Table I.*

No. of Expt.	Stress: Tensive. Loads in tons.	Strain: Extension.	
		Elastic Extension in inches.	Residual Extensiou or Set in inches.
	A	B	C
1	·47	·0090	Not visable
2	·70	·0137	·00022
3	·94	·0186	·00054
4	1·41	·0287	·00107
5	1·88	·0391	·00175
6	2·35	·0500	·00265
7	2·82	·0613	·00372
8	3·29	·0734	·00517
9	3·76	·0859	·00664
10	4·23	·0995	·00844
11	4·70	·1136	·01062
12	5·17	·1283	·01306
13	5·64	·1448	·01609
14	6·11	·1668	·02097
15	6·60	·1859	·02410
16	7·43		

* The figures are from Anderson's "Strength of Materials," Table II.

Set off two rectangular axes, *o x* and *o y* (fig. 72), along which, from the point *o*, make the measurements corresponding to the figures in columns A and B respectively. For those in column A, the scale used in fig. 72 is $\frac{1}{2}$in. per ton, as shown in fig. 73, and the readings corresponding to the first ten entries in the column are shown on the scale. For the lengths corresponding to the figures in column B, the scale shown in fig. 74 magnifies the actual measurement ten times; *i.e.*, it is a scale of 10in. to 1in., or 1in. to $\frac{1}{10}$in., and some of the measurements to be made along *o y* are shown on the scale.

If it had been wished to avoid the trouble of making a second scale, the same result could have been attained by multiplying the figures in column B by 10 in the present instance, and using the same scale as for the loads. But for the sake of practice in the construction and use of scales, the student should construct both scales in the following exercises. Having obtained the points 1 to 15, along both *o x* and *o y*, we draw perpendiculars from them to the axes. The intersection of each pair of co-ordinates is one of the required points on the curve of extensions. In the present example, the table being a synopsis of results, the points occur with nearly perfect regularity, so that there is no dubiety as to how the curve is to be drawn. But in other cases, when the points occur irregularly, a fair curve has to be drawn through them, *i.e.*, so as to average the irregularity as far as possible. The intersection of co-ordinates 14 and 15 may serve to illustrate this point. The position of the one is below, while that of the other is above, the natural continuation of the curve O E, as found to pass through the points on lines 1 to 13.

Next for the curve of sets. The figures in column C are read off on the same scale as that used for the elongations. The sets may be at once measured off on the lines representing the elongations, and the curve *o s* drawn through them.

[The interpretation of such diagrams belongs to the subject of the "Properties of Materials," but it may be mentioned here, to show the importance of being able to draw and understand these curves, that, by their means, the relative strength, stiffness, elasticity, and resistance of materials of construction can at once be made apparent. Altogether a much readier means is thus provided of showing the characteristics of a material than can possibly be given by tables of figures.]

PLAIN FACTS FOR FOUNDRYMEN.

A WRITER in the *American Engineer* gives expression to certain facts in relation to the method of conducting a foundry that are partially at least applicable to shops on this side the water. He says :—

"If there is any one want in a foundry that is harder to supply, that is more perplexing, and one which really should not exist, it is to get first-class mechanics. When we take into consideration the fact that in the foundry, perhaps more than any other branch of industry, 'there is plenty of room at the top,' it is puzzling to understand why there is not more attention paid to this matter.

"There is no time but what *good moulders* who are *sober men* are not in demand, and there is no time but what the country is over-run with men who *call* themselves mechanics, but who, when called upon to turn out a job requiring any degree of mechanical skill, are lost. It cannot be said that the foundryman is not of sufficient importance to warrant the outlay of time and study necessary to make him competent. It is not because the compensation of the moulder is not as great as other classes of mechanics, for his pay will compare very favourably with that of other trades. It is not because he has so much money invested in tools, nor is it because there is not enough change or excitement in his calling to relieve the monotony of it, but there certainly must be some good reason why the very army of poor moulders in the country do not, or did not, become more proficient.

"Is it because the foreman under which they served their apprenticeship took no interest in them, or is it that when they were apprentices they had the big-head to such an extent that there was no such thing as teaching them? It is the duty of every foreman who takes an apprentice to see that he is pushed forward just as fast as it is possible for him to go, and not, as is often the case, keep him on the plainer grades of work under the mistaken idea that he can make more money out of him in this manner. Beyond the shadow of doubt, the best way to make the most money out of an apprentice is to make him capable of doing the best work in the shop, by making him the best workman, for in this way you not only get the advantage of his superiority in the class of work he produces personally, but also in the influence he exerts over the younger apprentice, who will almost unconsciously follow his example. If turning out a superior grade of castings reflects to the credit of the foundryman, how much more important it is that his apprentices are turned out as a superior class of mechanics. How few of us seem to realise that at best it will only be a few years until our present apprentices will become the practical men of the day, from among whom the heads of all the iron industries are to be selected, and certainly the present outlook foreshadows such a revolution in the iron industry as has not taken place in the past century, and in no one particular branch is this revolution going to make itself felt as much as in the foundry.

"The time is not far distant when the foundrymen who occupy the front rank must understand the manufacture of *steel castings;* cast iron must give way largely to them. The demand is making itself more and more apparent each day ; they must be replaced by a substitute by which the strength can be maintained or even increased, and at the same time the weight materially diminished. This, it is true, has been accomplished largely by the use of malleable iron, but for the finer grades of machinery it is comparatively little used; its introduction has, however, made itself felt more in the manufacture of agricultural implements than in almost any other branch.

"Many foundries which in years gone by were crowded to their utmost capacity in this class of work find that they now have more room than they need."

CAST-STEEL WHEELS.

THE Pittsburg Steel-casting Company are making cast-steel car wheels by a method that was first used, we believe, by Mr. F. W. Webb, at the Crewe Works, although it is described by the *Engineering News* of America as a "newly-invented method." While the metal is cooling the moulds are put in motion, rotating swiftly, adding strength to the outer edge of the wheel. The wheels are said to have the advantage of great strength and durability, while made much lighter than even the paper wheel. The price will be placed at 2d. per pound. This makes them a little more expensive than cast-iron wheels, but they are still very much cheaper than either paper or steel built wheels. After the wheels are cast they are reheated, and rolled out on the tread and flange until they are perfectly round, in order to harden the wearing surface, and make the wear on the rails and springs less. The test required by the Pennsylvania Railroad for their wheels is five drops of 140lb. weights at 12ft. One of the new steel wheels was subjected to a test of this character, as follows : The drop was a distance of 12ft ; first, there were 40 drops of 163lb. ; second, 10 drops of 217lb. ; and third, 3 drops of 280lb. At the fifty-third blow, with the drop of 280lb, the wheel cracked. The test was then continued, 10 drops of 163lb. and 11 drops of 280lb. At the seventy-fourth drop the wheel broke. These figures show plainly the great strength of the wheel.

LUBRICATING LOOSE PULLEYS.

THE subject of lubricating loose pulleys is a matter of considerable importance to engineers, as in most cases efficient lubrication is rendered difficult, owing (says the *Engineer*) to the centrifugal action of the pulley constantly drawing the oil away from the place where it ought to remain ; and for the lack of some really positive lubricating appliance serious expense is frequently incurred in large establishments in the repair and maintenance of their pulleys. Mr. John Royle, of Manchester, has introduced an improved "positive" loose pulley lubricator, which is an improvement upon one that has been working in the north for some time. In designing the lubricator the inventor has taken advantage of the strap passing round the pulley to depress at each revolution a light spindle passing through the periphery of the pulley. The spindle works through a suitably-arranged cup containing oil, mounted on the boss of the pulley. The positive movement of the spindle at each revolution, though very slight, effectually overcomes the centrifugal force, and is found to feed the oil in a regular and trustworthy manner. By this arrangement a positive action is secured, in that the belt actually itself causes the spindle to act as a pump to press the oil through the tube or barrel surrounding it. The spindle passes through the rim of the pulley just sufficiently to be touched by the belt at each revolution, and, as already stated, the slight movement thus caused to the spindle simultaneously with the opening of a valve is found to give a practically positive feed.

MACHINES FOR PATTERN SHOPS.

For description see page 104.

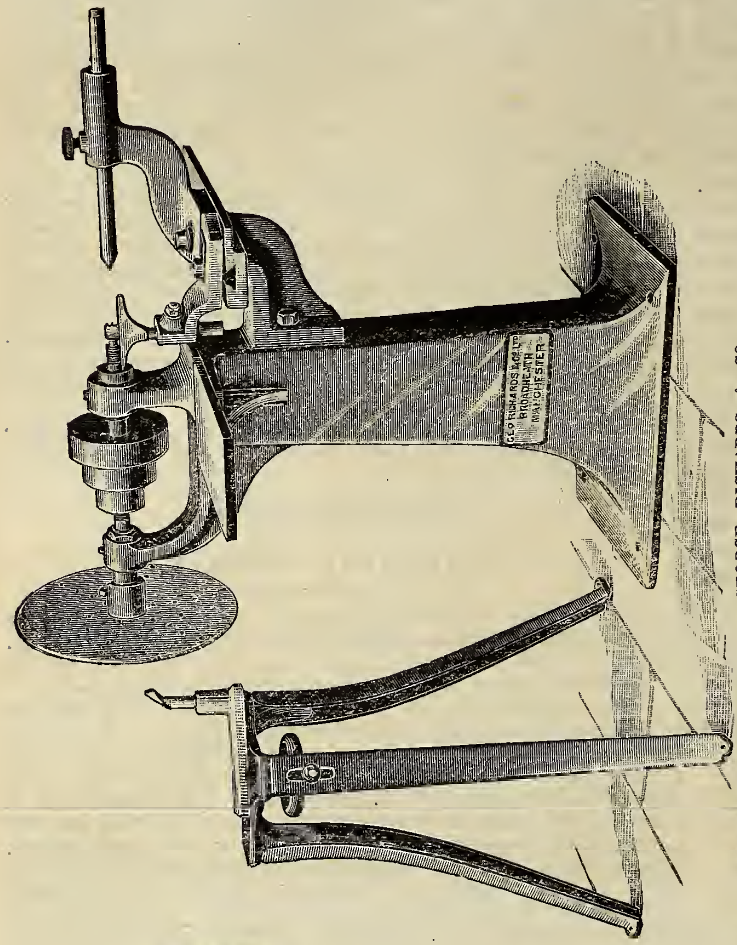


Fig. 3, LATHE AND REST.—GEORGE RICHARDS & CO.

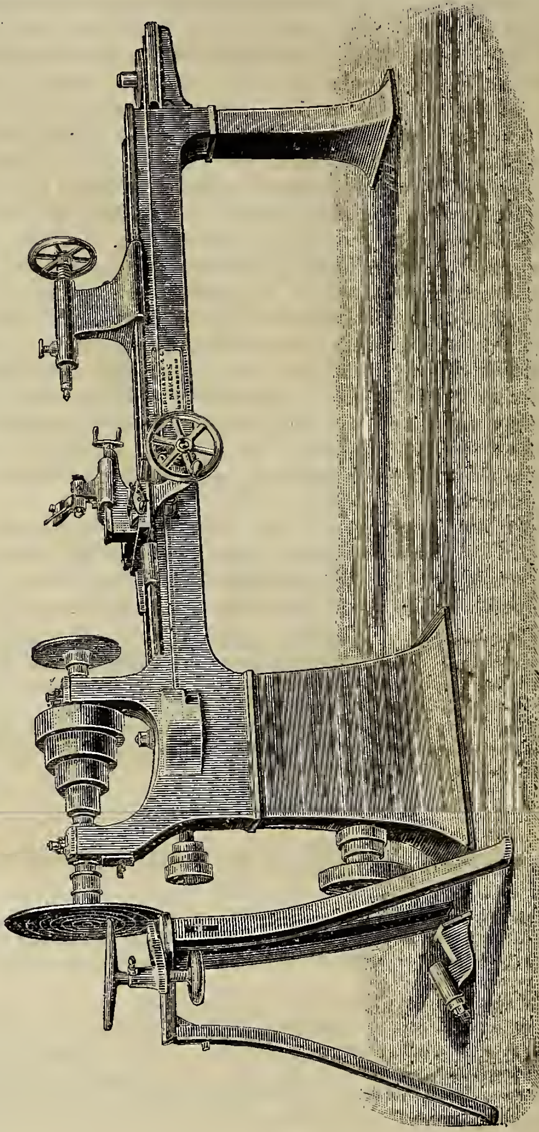


Fig. 2.—GEORGE RICHARDS & CO.

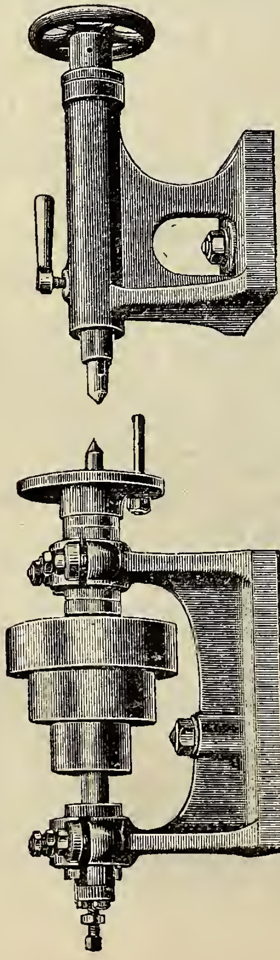


Fig. 1, LATHE HEADS.—ROBINSON & SONS.

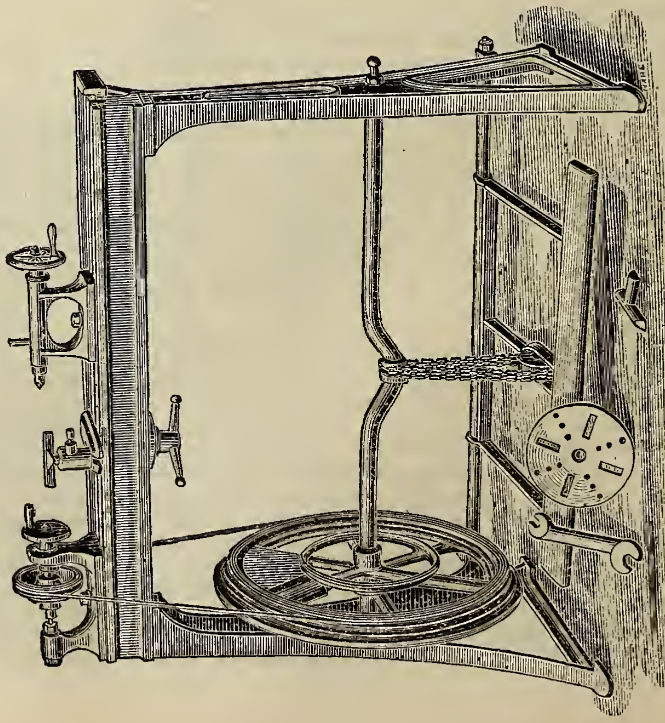
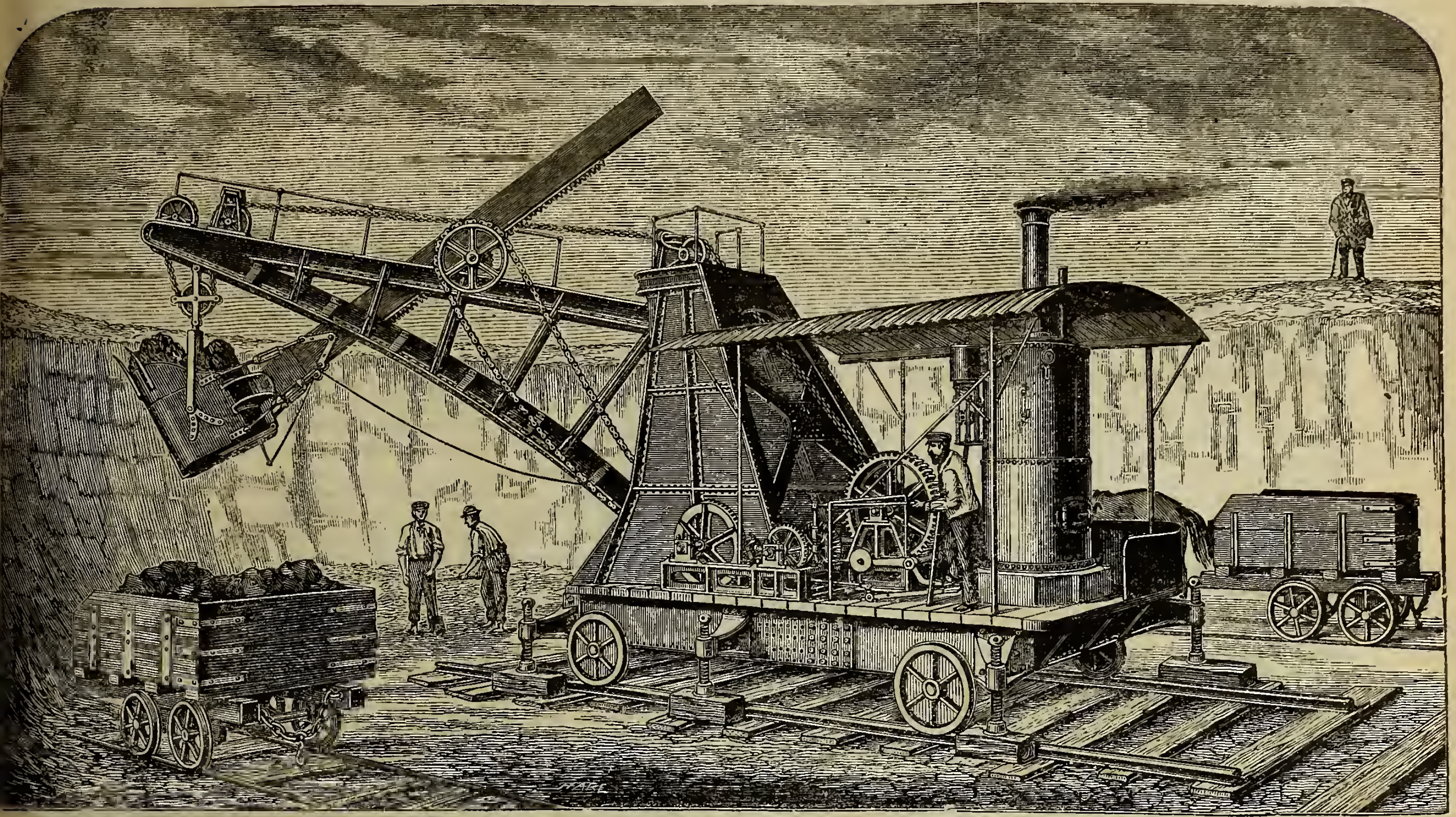


Fig. 4.—BRITANNIA CO.

PATENT STEAM NAVVY.

CONSTRUCTED BY MESSRS. RUSTON, PROCTOR, AND CO., ENGINEERS, LINCOLN.



The illustration herewith represents one of the steam navvies engaged on the Manchester Ship Canal works. It consists of a rectangular wrought-iron frame, made in two parts, bolted together for convenience of transport, running on four double-flanged wheels, but also fitted with six suitable jack-screws, by means of which these wheels may be lifted off the rails, when the whole weight of the machine becomes transferred to the jack-screws, and the steam navvy is then, for all practical purposes, stationarily fixed in working position. This main frame, forming the solid platform to which the whole machinery is attached, is constructed of wrought-iron girders, firmly braced to each other by cross frames. The rear end of the main frame carries a vertical boiler, of the cross-tube type, to which are bolted two overhead steam jacketed cylinders, each 7½in. diameter by 12in. stroke, which are in their turn connected to the crank-shaft bearings by the makers' well-known steam-expanding stays, as introduced on all their portable engines for taking up the variable expansion and contraction of the boiler-shell and mountings. The engine is rated at 10 nominal horse-power. The front end of the main frame carries a fixed post or tower, which is so arranged that its base, with the main frame, forms a capacious water-tank, chiefly for feeding the boiler, and partly for steadying the machine when at work. This post is made of wrought-iron plates, strengthened by T irons, and securely braced in all directions by angle-iron stays, while the tank is likewise well stayed, and over it, in combination with the frame, is a very strong arrangement of girders for supporting a wrought-iron jib (shown in our illustration), made with double side frames united in one vertical member at the tower end, and tied together at the other extremity, each being stiffened laterally by gusset-plates. Between the sides of this jib the handle of the excavating bucket works. The rise and fall of this arm is effected by a rack, shown on the underside of the handle, which gears into a pinion mounted on the jib, and which pinion is in its turn moved by a chain-wheel geared by the pitch-chain shown, the last-named being placed under the control of an attendant standing on a circular platform constructed at the foot of the jib post, a foot brake being provided to hold it at any required position. This constructive arrangement gives, as will be perceived, the swing radius of the handle, and, as the excavating bucket is fixed to its end, it follows that it similarly permits a greater or less depth of cut by the bucket into the soil to be excavated, while the rising and falling motion of this handle, which is made of oak, strengthened by iron plates, is attained by another mechanism mentioned lower down. The excavating bucket is securely bolted to the end of the handle, and is made of stout plate iron, strengthened by straps, gussets, and angle irons; its cutting edge is of steel, protected by four steel pointed picks for loosening the earth and stones. The plane end of the bucket forms a swing door, latching itself fast automatically, but opened by a cord worked by the attendant on the circular platform at the base of the tower. The raising and lowering of the bucket, and consequently of the handle itself, is attained by the chain-pulley combination shown at the end of the jibs, the driving chain used leading up to the winding and lowering drums placed on the main frame between boiler and fixed post, and actuated by the engine itself. Of these drums, the main drum carries the chain for hauling up the bucket when excavating, and it is geared directly to the engine crank shaft, being made conical, so as to proportion the speed to the power to the best advantage. From this main drum the second drum is driven for pulling back the bucket. The jib is allowed to swing, crane-fashion, and this is accomplished by driving a third drum off the second-named drum, by means of which the jibs may not only be made to swing, but as the third drum carries on the shaft a pinion connected to the fore-axle by a pitch chain, and clutches are also arranged so that either the pinion or the drum can be thrown into gear, the machine may thereby either be propelled or the jib swung round. All these drums are furnished with brakes, and a corrugated iron roof carried on wrought-iron pillars covers the machinery and engine.

Proceeding now to the method of working the steam navvy, we refer the reader to our illustration, which shows the machine standing in the middle of the cutting excavated, running on rails, but lifted off these by the screw-jacks. On each side of this centre line a set of rails is laid for the purpose of bringing up empty wagons, into which the full bucket loads are alternately discharged by swinging the jibs round over them. This arrangement is called the double road system, and is adopted in the construction of the Ship Canal. A continuous supply of empty wagons is kept up by bringing them over short jump-lines from a train of empties standing on a central road behind the steam navvy, whilst the full ones are drawn away along the side roads to make up a full train, which is run off by a locomotive, and tipped where convenient. When the now empty train is brought back to the rear of the navvy, its locomotive is detached and coupled again to another train of full wagons that have been filled in the interval, and so on. Presuming the steam navvy to be in full working order—that is, brought up to the face of the cutting—the bucket is lowered till its handle is in a vertical position, the engine is started, and the bucket is dragged forward and upward into the earth, the depth of cut being regulated so that it shall be full when it reaches the top position shown in our engraving. The jib is then swung round over one of the side wagons, when the bucket door cord is pulled by the fore attendant, thereby releasing the latch holding the bucket door, which falls open, and drops the contents into the wagon underneath it. The jib is next swung back again into a fresh position for another cut, and, the bucket being sharply lowered, the door closes itself automatically, and the process of excavating, &c., repeats itself. In this manner the steam navvy is able to excavate, and deliver into wagons, sand, soil, gravel, chalk, or clays of the hardest and toughest character, even when thickly embedded with stones and boulders, at a rate of 50 to 75 cuts per hour. When working on this double line system, as many as 240 wagons have been filled in ten hours, each holding three scoops full, which is equivalent to an output of more than 1,000 cubic yards per day. While the filled wagon on the one side is being taken away and replaced by an empty one, the bucket meanwhile discharges into the wagon on the other side, thus filling on the right and left side alternately without loss of time. The bucket is made to contain from 1 to 1½ cubic yards, according to the nature of the excavations, so that the output can be readily ascertained. When the navvy has circularly dug away all the stuff within reach, the six jack-screws are eased, and it is propelled forward on its rails three or four feet, and a fresh series of cuts is commenced. In this manner it advances, excavating a gullet varying from 20ft. to 30ft. deep, and from 50ft. to 60ft. wide at the top. In situations where the width of the required cutting will not permit the double road system of working by its being too narrow, one side road only can be used, or the navvy may work along the face of a bank, necessitating, however, more time in bringing up the wagons, and requiring more frequent stopping of the navvy for moving forward, thereby reducing the output.

The makers of these steam navvies are Messrs. Ruston, Proctor, and Co., Lincoln.

MACHINES FOR PATTERN SHOPS.

I am at a loss to account for the indifference of employers to the introduction of machines in pattern shops. The trade of the pattern-maker is usually, like drawing, regarded as a necessary evil, and for this reason, perhaps, the outlay necessary for machinery is grudged. I have been in a good many pattern shops, both large and small, and, except in one or two instances, have not seen what I should consider a complete equipment of tools. There are seldom more than the regulation lathes, band and circular saws, and these too often of types already antiquated, and fit only for the scrap heap. Tools become out of date, superseded by better ones, long before they wear out. To those who are familiar with the rapidly-increasing specialisation of every class of modern machine tools in the turnery and machine shops, in boiler and smiths' sheds, in iron and steel works, and in carpenters', joiners', and a host of other shops besides, it is a marvel why pattern-makers are so very little better off in this respect than their predecessors of twenty years ago. The reason, I think, must be sought not merely in the conservatism of employers and men, but in an impression which prevails that this trade, like moulding, is not one to which machine work is adapted; that the operations involved therein are so varied that machines can have only a limited sphere of profitable employment; that, in short, they cannot be made to *pay*. The writer has been engaged in this particular section of engineering for more than five-and-twenty years, and feels sure that if the pattern department of a factory happened to be a more costly item in the total expenditure of the works than it really is—if the number of men engaged therein were numerically large—we should have had our machines as highly specialised and numerous as those of any other branch of the engineering trade. But then the *proportional* advantage should be the same in a shop employing a dozen hands only as in one employing a hundred.

Preliminary to the consideration of pattern-shop machines we want clear ideas respecting the nature of the operations which are in most demand. Pattern work is *sui generis* among woodworking trades, having little in common with these except that the materials and the tools used are pretty much alike. There is at least as much difference between pattern-making and carpentry as there is between boiler and smiths' work, and more than there is between fitting and erecting. The fundamental principles, modes of construction, ultimate purpose and ends to be attained, mark this trade off by a sharp line of distinction from those of woodworkers in general. Only in a few of the merest mechanical details does similarity exist. Hence there are many costly machines which would be almost useless in a pattern shop. Thus there is, comparatively, little uniform boring of holes, scarcely any dovetailing, or ploughing, or tenoning done, and no heavy sawing at all. But the work lies mainly in turning, light sawing (both straight and curved), planing, and thicknessing (with and without taper in the thickness), finishing sweeped work of all imaginable curves (also with and without taper), the cutting of hundreds of feet of hollow and of angle, the making of large numbers of half-lap joints, and all the intricate and elaborate carving out of core box work. This is where the time is spent; hence we can say at once that neither general joiners, nor dovetailing machines, nor heavy saws are wanted, but machines instead, adapted specially to the particular operations named above.

I will begin with the lathes, as being absolutely essential. All the other machines *can* be dispensed with, the lathes never. Any piece of rubbish will not do—ought not to be made to do duty as a pattern-shop lathe. Accuracy in the fitting of a lathe, whether large or small, is of even more importance here than in those used for ordinary woodturner's work. Some portion, at least, of the pattern-maker's duties lies in the making of gear wheels, where a very little wobbling is fatal to the accuracy which should characterise them. Also in much of the small pattern work for gun-metal fittings the allowances for machining are cut so fine that the differences due to a badly-running mandrel would be more than equal to such allowance. Again, in all intricate work, as when finishing a bead, or moulding, or a deep hole, or a surface of quick curvature, the consequence of badly-fitting bearings is often a catch of the tool, and consequent disfigurement, and this due to no fault of the workman, but to that of the lathe. Hence slopwork, short bearing surfaces, light flimsy castings, are as objectionable for woodturning as for metal work. I would have stability, and the *best* workmanship, combined with very plain design—the plainer and simpler the better.

Fig. 1 illustrates a pair of good substantial heads for lathes of medium size, made by Messrs. Robinson, of Rochdale. A steel mandrel runs in gun-metal bearings, steel bearings not being suitable for woodturning, owing to the heat developed by the rapid revolution of steel in steel. The heads are adapted either to wooden or iron beds.

Pattern-maker's heavy lathes should properly be of a special type. Taking these first, we want, on the one hand, considerable *length*, and on the other *diameter*—length for columns and pipes, and diameter for wheel patterns, rings, pulleys, and so forth. A lathe of about 8in. or 10in. centre, with a bed say six or eight feet long, either of wood or iron, is very generally suitable for heavy work. In most cases such a lathe has to be used for doing both classes of work, the practice being then either to slew the fast head upon a base-block, either to right angles or completely round, or to turn it bodily round on the bed, so utilising the entire radius from the lathe centre down to the floor for turning facework. The tool is then supported on some piece of floor rest, whose dead weight is sufficient to preserve it steady under the stress of turning. A better and more recent plan is to have the mandrel screwed both back and front, so that either end may be utilised as required, the floor rest still being retained. Fig. 2 shows such a lathe, made by the firm of Geo. Richards and Co, Limited. In this it is necessary to unbolt the bracket at the tail end, which receives the pressure of the thrust screw, before attaching the faceplate. The hollow-framed casting immediately under the headstock is a good feature, as tending to deaden the excessive vibration which is set up by heavy turning. The very plain self-acting feed motion shown in the figure is very advantageous in shops doing much small pipe, column, and cylinder work, saving the labour of turning parallel work in a slow tentative fashion, the rest performing it automatically.

The length of bed in a lathe of this character is, unless specially ordered, not sufficient to take in the longer pipes and columns, which are often from 9ft. to 12ft. or 15ft. in length. Then there are two courses open, either to turn these patterns in one of the ordinary self-acting lathes in the machine shop, with a tool set in the sliderest, or to employ a special lathe, with wooden bearers of as great length as are likely ever to be required. A couple of stout pitch-pine bearers, fitted with heads like those in fig. 1, and a plain T rest, will make a cheap and most serviceable lathe in a pipe, or column, or jobbing shop. I have seen the bed in a lathe of this kind utilised for a couple of smaller lathes, their beds being bolted to short standards, bolted down to the wooden beams of the large lathe in such a way that they could be detached in a few minutes when the full length of bed was required for the larger lathe, which, of course, only happens occasionally.

Fig. 3 shows another of Geo. Richard's specialties for face and boss turning only, the first named being done on the left-hand side in the figure, the second on the right. The headstock and base are in one casting, in order to obtain rigidity and freedom from vibration. A lathe of this special character would be a most desirable acquisition in almost any pattern shop.

Lathes of the classes hitherto noticed are necessarily driven by power, as are also the smaller lathes in factory workshops. It does sometimes happen, however, that there are pattern shops so situated that power is not readily available, either by reason of their remoteness from the motor which supplies other portions of the factory, or in cases where pattern work is done independently for the trade, as in some of our larger towns. Ordinary treadle lathes must then be used for small work, and the heavy turning put out. In cases like this the very plain and cheap lathes made by the Britannia Company, of Colchester, are excellently adapted to the requirements of the pattern-maker. I should then select a 5in. lathe, single geared only, and with or without a gap. If a lathe of higher centres than 5in. is used, the labour of driving the treadle becomes too heavy, when a fly-wheel turned by an assistant becomes necessary, or, what is preferable, a small gas engine. The writer has seen a lathe which the Britannia Company has recently introduced for woodturning, and it is rather a marvel in its way—a 5in. lathe, constructed entirely of iron and steel, and costing only £4 10s.

But a much superior tool is that shown in fig. 4, amply rigid, and accurate enough for any work which the pattern-maker may have to do. It is a good typical lathe for light woodturning, and, though furnished with a treadle, it can, of course, be driven by power from a countershaft, like the larger lathes. It is often an advantage to have both means of driving available in the larger shops, to be able to do odd jobs during overtime without running a whole line of shafting for the purpose.

I have thus briefly described the general *types* of lathes best suited to our special work, and in which simplicity of construction should always be combined with the best workmanship. The chucks required are merely the cup, the fork, and the face, so that these call for no special remark. The machine tools required for the other operations enumerated at the commencement of this paper will be treated of in subsequent articles.

J. H.

THE ANDERTON LIFT.

At a well-attended meeting of the Manchester Association of Engineers, held on Saturday night, Mr. Samuel Dixon, the president, in the chair, Mr. Lionel B. Wells, of Goole, read a paper in which he described in detail the engineering features of the hydraulic river and canal boat lift at the village of Anderton, about one and a half miles down the river from Northwich. The canal at Anderton is 50ft. 4in. above the river, and the lift was constructed by the trustees of the Weaver Navigation to enable boats to pass from the river to the Trent and Mersey Canal, and *vice versa*, in order to avoid the transhipment of goods at that place, or the delay and inconvenience of going *via* Runcorn, through the many locks there concentrated. The works consist of a basin opening into the canal, from which a wrought-iron aqueduct leads the water to a lift-pit, which is connected with the river Weaver by a side channel. The lift is double, so that one barge or two canal boats can be passed each way at one operation. This not only saves time, but the weight of the descending load is nearly sufficent to elevate the ascending load. The works were carried out, at a cost of £42,000, from designs by Mr. Leader Williams, then chief engineer to the River Weaver Navigation, now engineer to the Manchester Ship Canal Company.

Messrs. Vickers, Sons, and Co.—This firm pay a 9 per cent. dividend for the past year, as against 14 per cent for 1886. The company has now had an exceptionally long season of good profits, but the increasing severity of competition has at last apparently affected their trade.

CONDENSATION IN STEAM-ENGINE CYLINDERS.

A writer in the *Engineer* makes an excellent suggestion, as follows, regarding a method of watching the condensation in steam cylinders: "Some time ago I had occasion to see at the works of Mr. Richard Schwarzkopf, at Berlin, the interior of a steam boiler splendidly lighted by electricity. It was most interesting to watch the state of the water surface under different conditions of heating it. Now, reading your able article in one of the last numbers of your valuable journal, on internal condensation in triple expansion engines, it occurred to me that perhaps the mystery about their economy might be cleared by being able to watch what is going on in the interior of the cylinders of a steam engine by the same means as Richard Schwarzkopf employed to light the steam boiler. On application this gentleman is sure to give all information about the affair, or supply the necessary apparatus."

CORRESPONDENCE.

We do not hold ourselves responsible for the opinions of our Correspondents.

BOILER REGISTRY AND INSPECTION BILL.

To the Editor of "The Practical Engineer."

Sir,—Having favoured me on many occasions by inserting my somewhat incomplete and often uncouthly expressed sentiments, I feel sure your readers will give me credit for being an avowed advocate for having none but the most reliable men in charge of engines and boilers, and in my comments on the letter this week from "Public Interest," I would simply say my principles are unaltered; but I feel assured that if the course suggested in his letter were followed, it would be most fatal to the cause he now advocates. He refers to the speech of the Chairman of the Oldham Chamber of Commerce. I think all who read this speech *in extenso* would be surprised at the language used, not only by the chairman but by other members. The letter by "A Foreman," in your issue of January 13th, is worth notice. Certainly such assemblies as the Oldham and Blackburn Chambers of Commerce are quite justified in reviewing and passing resolutions on the above bill, which was left over and sent before the country for that purpose, so that the promoters of the bill might have the ideas of steam users generally to assist them in bringing it into such a form as to present it to both Houses of Parliament. The two chambers mentioned are among the most representative of the steam-using public, and yet their decisions are diametrically opposed to each other, insomuch as the Blackburn Chamber form no objection whatever, only that the cost has not been mentioned; and why? Simply because the steam users in that district have already (with a very few exceptions) adopted with advantage to themselves that course which is now embodied in the proposed bill, namely, that of having their boilers regularly examined by those who have made boiler keeping a specialty, and as a consequence the Blackburn district for some years has been practically free from explosions. On the other hand, the Oldham Chamber see everything that is bad in the proposed bill. Why this is so I cannot imagine, as from my own experience of the Oldham district I do not see how, when, or where the shoe is likely to pinch, with the exception of, perhaps, one large firm, and a few other very small ones; for, speaking of Oldham generally, the boiler keeping is in my opinion far above, and explosions very far below, the average of most other districts; and I believe, further, that if any other gentleman had been chairman, and opened that meeting, the result might have been different. One of the objections lies in his fancy that "skilled labour" will have to be employed in the form of certified stokers, &c., and this was no doubt found to be a tender string to play upon in the presence of the other employers, who, in common with all employers, have a dread (rightly or wrongly I do not say) of trades unions, and the certification of stokers would certainly be legalising a vast trade union with an amount of Government protection, while the so-called union would probably be composed of theoretical rather than practical men, and many who now have charge of engines and boilers would be quite unable to pass an examination, while it would be next to impossible to get better practical men. It has been shown by many that if we must have legislation, it is the boilers that must be legislated for and not the men. If we examine the Board of Trade returns on explosions since 1882, we find very few cases of explosion from ignorance; for when ignorance and negligence are taken together we have in the years July, 1883, three cases out of 45; June, 1884, three cases out of 41; June, 1885, four cases out of 43; June, 1886, six cases out of 57; June, 1887, three cases out of 37; or a total of 19 cases of ignorance and negligence out of 223 explosions. Many of the cases out of the 19 cannot really be put either to negligence or ignorance. For instance, No. 69 explosion was purely a case of forgetfulness; No. 80 was due to skilled malice; 96, 103, and 128, accumulations of deposit and salt; 143 due to scale, and 282 deposit of salt. These causes are practically outside the control of the attendant, thus reducing the 19 cases to 12. It would, of course, have looked better if there had been none. In my opinion it will be best for inspectors and qualified engineers to wait patiently, and rest assured that if the present bill or any other is forced upon steam users, all the good men will be wanted. If they begin to agitate they will certainly stifle their own cause. There are good times coming, but they will be delayed by trying to hurry them.—I am, yours, &c.,

CHALKLINE.

To the Editor of "The Practical Engineer."

SIR,—I find in your issue of last week one signing himself W.B. failing to see why the Board of Trade certificate should be required of engine attendants, or at any rate in a Boiler Registry Bill. Perhaps it would be as well if the bill were made one for Boiler and Engine Registry, but I think there is no one would like to take that to Parliament, so that it would best be added to the Boiler Registry and Inspection Bill. As regards engine attendants, I have the same opinion as W. B., but there are not many places in which the engine attendant understands the boilers as he ought; and as to the question which W. H. asks, viz., if the bill passes should I dismiss all enginemen and stokers at once if they could not produce a Board of Trade certificate after having had 20 years' experience, I should think that a man after having that experience would not be afraid of Board of Trade inspection; if so, he is just the man that ought to be dismissed. The way W. B. looks at this matter, if general, would lead us to continue to be hampered with ignorant and unqualified men. I should like to refer W. B. to the letter in the *Engineer* of the 24th inst., on the subject. Hoping I am not trespassing too far on your valuable space, I must say that I am very pleased that it has caught the eye of someone, and hope that this matter will be taken up by all who trust to steam as a motive power.—I remain yours, &c., PUBLIC INTEREST.

Leicester, February 27th, 1888.

To the Editor of "The Practical Engineer."

SIR,—I am of the same opinion as "Public Interest"—that no man should have charge of engines or boilers without a Board of Trade certificate. Why should the marine engineer have it and not the stationary engineer? It is for the benefit and advantage of the engineman; therefore we should agitate for it. The masters will put it down if they can, as it is against them. Some proprietors do not care what kind of a man they have, as long as the engines and boilers are insured; any novice will do if his wages are low.—Yours, &c.,

Bradford, February 21st. CONSTANT READER.

To the Editor of "The Practical Engineer."

SIR,—I see by your valuable paper that notice of the above bill keeps cropping up from time to time, and I think rightly so, too. In your issue of February 17th, "Public Interest" calls attention to the remarks of S. R. Platt, Esq., made some time ago, at the meeting of the Oldham Chamber of Commerce, which I think were very sarcastic, and a little out of place. I should like to ask Mr. Platt if the remarks he made at the above meeting were his own, or were they put into his mouth by some of his colleagues, who view everything that tends to the public good with an adverse eye? I am thankful for small mercies, and am glad that such remarks and the resolution passed by that august assembly were not passed unanimously, for there was one, at least, who dared to state his opinion, although it differed from the majority. But let us see how such a resolution fared in other quarters—for example, the Associated Chambers of Commerce. Here we find things changed; the resolution proposed by the representatives of the O.C.C. was rejected, and the bill declared for; and I believe I am right in saying Oldham representatives were the only ones that voted for their resolution, or anyhow not more than one other place was with them. I expected to find a report of the A.C.C.'s proceedings on the above bill in your issue of this week (Feb. 24th), but I am disappointed. I hope you will be able to give it as soon as convenient, as you were careful to give the report of the O.C.C., and in so doing you stated they had an animated discussion on the bill; but I fail to see how it could be animated, as they had it all their own way with the exception of one or two. Again, Mr. Platt says "the bill is absolutely unnecessary, and if passed would inflict great hardships on boiler owners." I would ask him how? Again, he says "there are several boiler institutions, and for a very small sum per annum steam-users could have their boilers inspected," &c. Just so; but we know that a great many owners do not take the advantage of paying the small sum, and it is for these that the bill is mostly drawn up. Again, he looks on this bill as "a piece of grandmotherly legislation, and got up for the purpose of making a sound," &c. These appear to me very sarcastic remarks, for I fail to see what advantage anyone could gain by bringing in a bill of this description for the mere purpose of making a sound. I may say I am rather sorry that the mechanical engineers and others interested have not discussed this matter more. I would advise all engineering societies to bestir themselves and do their utmost to get this bill made law, not exactly in its present form, as I think it wants amending in some details; the proposals of Mr. Ingham, for instance, would be beneficial, if they could be added.—Hoping you may be able to find space for the above, I remain yours, &c,

February 28th. BILL.

POLLITT AND WIGZELL'S ENGINES.

To the Editor of "The Practical Engineer."

Sir,—No doubt many other readers, in common with myself, will regret that "J. W. J." has thought fit to apply the "cloture" so suddenly to the impending discussion on the above-mentioned style of engine, which would, in all probability, have followed the publication of the diagram. For my own part I cannot see that any disadvantage could have accrued to your correspondent from the publication of his diagrams, whilst a fair discussion of them might reasonably have been expected to increase our stock of knowledge on the subject. In regard to "L. R.'s" remarks as to high temperature of water ejected from condenser, I am in unison with his opinion that 80 or 90 degrees would show a better vacuum, and if the reason "J. W. J." gives is the only one for the high temperature adopted, I rather suspect that the alleged economy in steam in wash-house is purchased somewhat dearly, especially if the engine in question has anything to do. So far as the low-pressure piston rod being to blame for the reduction of port area is concerned, I may say, if the latter was not in the way of the former the piston rod need not pass through it. Now, the piston rod cannot very conveniently be arranged otherwise than as at present, but the valve box can, and I am strongly of opinion that if the valve chest were placed on the top of the cylinder, with a separate short slide-valve at each end, the improvement attained would more than compensate for the increased complication of the valve gear, which, after all, need not be so formidable. I cannot agree with "J. W. J." that these are matters of opinion; they are not, but they are matters for thought, investigation, and discussion, and cannot help expressing a regret at the tone of the concluding sentence of his last letter. In conclusion, perhaps it may not be out of place to remark that only a day or two ago I saw one of P. and W.'s engines, which has been working with a full load on since about 1874, and the cylinders have not yet been bored out. Not so bad, considering that the engine is still in good order, and driving its load as of yore.—Yours very truly, J. S. S.

February 27th, 1888.

To the Editor of "The Practical Engineer."

SIR,—Will you kindly allow me a few words in your valuable paper. I am very much disappointed at your not being able to comply with the unanimous desire of your readers in reproducing the diagrams of J. W. J. But I feel sure that some brother of the wheel will champion J. W. J.'s cause. We have a great many of this class of engines in Bradford, and what results can be got at Wakefield ought to be got here, though I have never yet seen diagrams of this class of engine with more than 75 per cent. of boiler pressure at point of cut off. Perhaps some of your readers will send you some for publication. A friend of mine who has one of these engines has often said that we have not one in Bradford consuming less than 3lb. of coal per H.P. per hour, and he says that they will never break down, simply because he can get nothing on the piston. Other makers are as bad as this in some cases, and the result from this correspondence will, I believe, recompense you for your trouble and time; and if it is not too much to ask, I should be glad if you, or any of your readers, would give me your opinion on the enclosed diagrams. My engine is of the tandem compound type, with Corliss gear, made by Marsden's, of Heckmondwyke, and I think our consumption of coal will compare favourably with a many of this class, and I shall be happy to exchange visits with J. W. J. or any of your readers, and compare notes, or I will allow any of your readers to come with his own indicator to test the accuracy of these diagrams, if they bring a note from yourself.—Yours, &c., J. H.

Knowles Lane, Dudley Hill, Bradford.

[The diagrams forwarded by our correspondent show the valves to be well set, and there is, apparently, no undue restriction in the ports. We have not had time to work out the figures fully, but we should expect that the engines are working very economically, mainly on account of the heavy load they are driving. The high-pressure figures show 57 and 58 lb. respectively on the piston, against 60lb. in the boiler, and this high pressure is carried on for one-third of the stroke. The vacuum in the large cylinder is 12½lb.—ED. *P. E.*]

MARINE PROBLEMS.

To the Editor of "The Practical Engineer."

SIR,—In reference to J. R.'s observations on "Marine Problems," I beg to say that if a steamboat, which would be able with the engines at full power to go through still water at ten miles per hour, be in a stream running three miles per hour, and a floating body be drifting down the stream ten miles above the boat, the boat engines being at rest, then the vessel and floating body will move at the same speed, and the floating body and the boat are relatively at rest. If the engines now be put on at full power, with the boat heading upstream towards the floating body, it will arrive at the float in one hour, having in that interval passed through the intervening ten miles of water. Again, if the float be ten miles down stream, and the boat heads for it under full power of the engines, it would again come up with the float in one hour, and the water pressure in such case is equal on each side of the boat. Again, if we suppose the boat heading at right angles to the stream, and to be ten miles from the float which is in line with the keel of the boat, if the engines now propel the boat at the same speed as before, or exert their full power, in half an hour the boat will be five miles from the float, the boat and float having each been carried by the current 1½ miles down stream, and the line of keel will be still at right angles with the stream and in line with the float; in another half-hour the boat will have passed through the intervening ten miles of water, and come up with the float; the float, boat, and water having been carried with the current during the hour three miles below the line from the point of starting. The water pressure will of course be the same on each side of the boat while being drifted down in the current, as it is also on the opposite sides of the float; for if it was greater on the up-stream side, that greater pressure would force the float down stream quicker than the current flows; if it was not greater, but less, then the greater pressure on the down current side would retard it, or perhaps even send it back in opposition to the current, a condition of things which we cannot suppose. Therefore, whether the boat go up, down, across, or at any other angle with the stream, the current will have precisely the same effect on it as on a floating body at liberty to move in and with it, and the boat will in all cases be carried along by the current in the direction and with the velocity with which the current moves, whether the engines be working or not; the pressure of the water in all cases being the same on each side of the boat.—Yours truly, W. A.

132, Marlborough Road, Cheetham.

TALLOW CUPS V. SIGHT-FEED LUBRICATORS.

To the Editor of "The Practical Engineer."

SIR,—In your issue of last week "Artizo" says the sight-feed lubricator often struck him as being very wasteful in the amount of lubricant used; but I think it would have been more to the point if he had given the quantity used by the pair of tandem engines he indicated, for I cannot see what indicating has to do with lubricating, unless he had given the quantity used before adopting the sight-feed. Now, sir, I contend that the sight-feed process is more economical than the tallow cup process, besides being much cleaner, and I will give him my own experience with a pair of McNaught beam engines; cylinders 27in. and 37½in., 5ft. stroke, 37½ stroke. Here, the four pistons are travelling at the rate of 1,125ft. per minute, and half a gallon of cylinder oil will lubricate them and the valves also, which are automatic cut-off, for ten hours, and keep both cylinder and valves in first-class order; whereas before adopting the sight-feed I used something like one and a half to two gallons per ten hours, and then the pistons were constantly groaning. All my valves are hung from the bottom, and most engineers know what a difficult matter it is to keep the valve spindles lubricated and the packing in good condition (at least I did) with the old tallow cup. But now I have no trouble to keep them lubricated with the sight-feed, through vaporising the lubricant and saturating the steam with the greases. Now, I make it my duty to examine the pistons and valves four times a year, and I am so far convinced, after four years' experience with the sight-feed lubricators, that it is the proper way. The essential points to be sought for in attempting the successful and satisfactory lubrication of cylinders are—first, that the supply of the lubricant should be automatic; second, regular and visible; and third, entirely under control. And we have all these in the sight-feed lubricator. At least this is my practical experience as a user and not a maker or dealer.—Yours respectfully, SIGHT-FEED.

February 27th.

[Several letters have been crowded out this week.]

QUERIES AND REPLIES.

EMERY WHEELS.—Will someone inform me of a good solution for securing emery to an emery wheel?—CONSTANT USER.

Answer.—Manufacturers of emery wheels usually keep secret the nature of the composition they use to cement the emery together. Resin, sulphur, shellac, and pitch are the principal ingredients in most mixtures, but vulcanite and celluloid are also used. Ransome's emery wheels are formed of an insoluble silicate, or artificial stone, which, however, is much softer than the emery.—G.

COPPER CYLINDERS.—Could any reader kindly give me a simple, but reliable, formula for the collapsing pressures of copper cylinders subjected to external pressure? The dimensions of the cylinders vary from 12in. to 36in. in length, and from 12in. to 36in. in diameter.—OLD FINSBURIAN.

Answer.—To give a formula for the collapsing pressure of externally loaded copper cylinders requires full information as to surrounding circumstances and conditions. For example, what sort of copper is used—sheet or cast? Are the edges brazed to form the cylinder or riveted? and if so, by single lap or butt-joints? Is the copper of the cylinder so thick that the cylinder may be cast without joint? also, whether, and by what means, the ends of the cylinder are kept to their proper circular shape while it is subjected to the pressure? Without the above information, of course, no reliable formula can be given.—W.A.

BRAKE TO PREVENT OVERWINDING.—Could any reader give me a description of the automatic brake to prevent overwinding as used in mines.—W. R.

Answer.—The most simple form of automatic brake is brought into play by the cage coming into contact with levers overhanging the shaft at a point which the cage, when under proper control, ought not to reach, which raises the levers and puts into action a steam brake acting directly on the drum. There is also an arrangement to stop the cage at the pit top in case the engineman neglects to turn off the steam, whether caused by absence of mind, fits, illness, or any other cause.—MINING ENGINEER.

[WE hope to print shortly a series of articles on "Prevention of Overwinding," which will deal with detaching hooks and self-acting brakes.—ED. P. E.]

BRICKMAKING MACHINERY.—Whose brickmaking machinery is most suitable for working up colliery spoil banks? A general description of the arrangement and some idea of the cost of a 20,000 per day plant would be very acceptable.—G.

FAUCET JOINT.—What is the best means of making a steam faucet joint tight at 40lb. pressure?—W. S..

ILLUMINATING PAINT.—I should be glad to have the address of a maker of illuminating paint.—S. C.

SPEED OF VESSELS.—Can any reader give me a formula for obtaining approximately the speed of a steam vessel with a given H.P., without going into any very intricate calculations.—F. W. B.

STEEL CASTINGS.—Would any of your readers give me any information as to the theory of moulding and casting the above? Also if there is any work published on the subject?—MOULDER.

STEEL PLATES.—Will some reader kindly give me a list of lengths and widths of iron and steel plates kept in stock by most merchants. What I want is to be able to design tanks, boilers, &c., without having to get them cut, as this increases the labour, and does not add anything to the strength.—H.L.C.

CLEANING SKYLIGHTS.—Which is the best way to clean skylights in an engineering works, where soot and dirt stick fast on the glass? What is the best thing to use with water so as to fetch the dirt, &c., off quickly and cheaply?—J.A.

AUTOMATICALLY CLOSING A STEAM VALVE.—Can any of your readers inform me of a method for automatically shutting, in a given short time, a steam valve that is opened by a movement which is too quick to be utilised for closing it, and where there is no other motive power available? I have heard that a wing valve would be suitable, but have no knowledge of such a valve, and should be obliged for a description of it, or any other method that would answer my purpose.—PISTON.

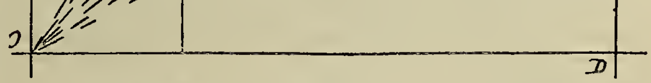
Could any reader inform me how I am to make the following: I want some aluminium tubes about 1½in. diameter, ⅛in. thick, and about 1½in. long, with flanges on the end. Can I buy the tubes ready made and solder the flanges on, or should I have to get sheet metal, and bend it over, and solder it up all along to make them? What would be the best kind of solder? Is aluminium very expensive, and who manufactures it?—W. Ll. P. W.

TO CORRESPONDENTS.

J. E.—Except for very fine calculations, the units of heat put into the water from temperature of feed to 212° are simply the degrees of temperature the water has been raised to. In your case the first column is 212 - 90=122. The units of heat in steam at any pressure are got from tables such as the one in Templeton's Workshop Companion. At 16lb. pressure by the gauge, the units of heat above that at 212° are 1079·5. Note that total pressure means gauge pressure plus 14 7lb.

HYDRAULIC.—We cannot explain the peculiar action of the rams when coming together. It would seem from the drawing that if any movement at all takes place it should be in the reverse direction.

CONSTANT READER.—Suppose OA, OD are the two lines of reference or asymptotes, as they are called, of the hyperbolic curve, and B is the point through which the curve is to be drawn. Draw BF and CE parallel to OA, and BE parallel to OD; take any number of points, p_1p_2, &c., between B and E, and join each point to O by lines cutting BF in q_1q_2, &c. Complete the rectangles p_1q_1, p_2q_2, p_3q_3, &c., thus obtaining the corners through which the curve must be drawn by hand, as shown in the diagram.



BELFAST.—The powers of the engines are based on a working pressure of 160lb. per square inch In some instances 165lb. and 170lb. have been carried, more to ensure that 160lb. would be easily kept up in ordinary work than for any increase in the power. The series will be continued, with notes on propellers, pipe arrangements, &c., in due course.

G. B.—Apply to any of the steam shipping companies, unless you have a preference for a particular line.

LEAKY TUBES.—The tubes probably require new ferrules.

LEAKY PIPES.—These tubes should be solid-drawn. The brazing has evidently been badly done.

LARGE BOULDER.—A boulder of unusual dimensions was raised to the surface in Oxford Street, Manchester, on Saturday last. The stone was discovered during some sewering operations at a depth of about 40 feet from the surface. Its weight is estimated to be 30 tons; in shape it is oblong, measuring in height about 10ft. The boulder has been presented to the Owens College Geological Museum, and was transferred to the quadrangle of the College on Tuesday night. Messrs. Whitworth performed the difficult task of raising and moving the stone.

MISCELLANEA.

North German Lloyds New Steamer.—The directors of the North German Lloyds Steamship Company have decided to build a new fast steamer for their mail lines. This vessel will be constructed in a German yard according to the stipulations of the German mail contract. It will be the second large fast steamer built in Germany, the Hamburg-American Steam Packet Company having already had a similar vessel built by the Vulcan Shipbuilding Company of Stettin.

A Locomotive on the Stage.—An entirely new realistic effect has been produced on the stage of the Standard Theatre, by the introduction in a new sensational drama of a real locomotive and goods train. From sidings laid on the stage a train is made up, and then starts off on the main line—the rails and other plant being all of steel—with the locomotive in full steam, the driver at his post, and all the other accessories of the real thing. The locomotive and wagons were made by Messrs. Kerr, Stuart, and Co.

Large Bronze Statue.—A colossal bronze statue of William Penn is now being prepared to grace the clock tower of the new City Hall in Philadelphia. The figure will be nearly 40ft. high, and will weigh over 30 tons. The legs are to be 20ft. long, and the Quaker hat brim will measure 22ft. round its edge.

Railway Strike.—The engine drivers and stokers on the Chicago, Burlington, and Quincy Railroad struck work recently, demanding the same pay for all grades, instead of the pay varying, as at present, according to the length of service. The company has suspended the goods traffic, but will maintain the passenger train service. It is being helped by the Knights of Labour, who are securing other drivers and stokers for it. These new hands are mainly unemployed strikers from the Philadelphia and Reading Railroad, who desire to oppose the "Brotherhood of Locomotive Engineers." The brotherhood, which is responsible for this Chicago strike, recently filled up the places of those who left work on the Philadelphia and Reading Railroad. Some 1,600 drivers and stokers are idle, and the strike deprives 10,000 men of employment.

Wagon Couplings.—The Great Western Railway Company are introducing the use of the shunting pole, and have recently instituted a series of contests among the porters, with prizes, in order to encourage the use of the new appliance. The shunting poles used were of two patterns, known as the "Great Western" and "North-Western," the result of the recent trials being to confirm the view that the latter was the preferable one; but there was some drawback to the experiments, owing to the fittings not being uniform.

The Delagoa Bay Railway.—This question was broached in the House of Lords again on Monday, by Lord Rosebery. The Earl of Onslow, replying for the Government, thought they could not be expected to purchase the railway, inasmuch as it did not run to, from, or in British territory. The Cape and Natal are the nearest concerned in this affair, and they are quite competent to look after their own interests. A conference has been held between the Orange Free State and the colonies of the Cape and Natal, and as a result it is thought that a better arrangement for the working of railways in South Africa will follow.

Boiler Explosion.—An explosion of a boiler on the ferry-boat Julia, at Vallejo, California, was a fearful disaster. Of the 63 persons on board 24 were killed, while all the others were injured, several of them fatally. A fire broke out after the explosion, burning the steamer to the water's edge. Finally, she sank with the corpses buried under the wreck.

Spanish Engineering Works.—One of the results of the movement in Spain for the establishment of works and shipbuilding yards on Spanish soil, by foreign firms, has been the formation of the "Naval Construction and Armaments Company, Limited," with a capital of £600,000, a portion of which was offered for subscription last week.

Engineering Society, King's College, London.—At a general meeting, held on Tuesday, February 28th, the President in the chair, Mr. Schwartz read a paper on "Water and Water Supply." The author commenced by discussing the chemical and physical constituents of water, dealing with the impurities which produce disease. With regard to the purifying action of the open flow of water in rivers, aqueducts, &c., and the percolation through soil and rock to deep wells, it is purified from all dead organic matter, but not from living forms. Diseases are conveyed through water by the organism bacteria, which can be partially destroyed by boiling the water; but boiling does not kill the spores. Corrosive sublimate is the only universal germ destroyer. These germs not only produce disease themselves, but they contaminate the water chemically by the production of non-living substances which are highly poisonous. Another source of impurity is the contamination by metals; this is much more easy to deal with than the other. The author then pointed out the advantages of collecting rain-water from the roofs of houses, and described Mr. Roberts' Rain-water Separator, an ingenious arrangement for allowing the first portion of the rainfall, containing the dirt from the roof, to escape, while the purer water is collected in a reservoir. The author then proceeded to discuss the subject of natural springs and wells, and, in conclusion, a short history of the London water supply was given.

APPLICATIONS FOR LETTERS PATENT.

February 17.

2380 Warming and Ventilating Rooms, David Williamson and Robert Williamson, Liverpool.
2381 Fire-Clay Slabs for Boiler Furnaces, John Harrington Hall, London.
2384 Water Tube Boilers, Johnson Mills, Manchester.
2385 Ventilators, Henry Thomas Johnson, Manchester.
2387 Rotary Engines, George Pinnington, Chester.
2393 Wood Planing Machinery, George Pickles, Halifax.
2400 Blower and Exhauster, Frederick Harvard Stacey and Henry Wilkinson, Sheffield.
2401 Expanding Piston Rings, Joseph Crowther, Manchester.
2402 Regenerative Furnace, Walter Fitzallen Simpson, Burnley.
2409 Railway Signalling, John Kendall and Owen Cooper, London.
2412 Manhole Chambers, William Dundas Scott-Moncrieff, London.

February 18.

2432 Excavating Grabs, Francis Gould Morony Stoney, Glasgow.
2434 Gas Governor, David Burce Peebles, Glasgow.—[Complete Specification.]
2442 Smoke-Preventing Furnace, William Begg.
2444 Car Couplings, Francis Marion Rariden and Alfred R. Heath, London.—[Complete Specification.]
2446 Valves, Thomas Elcoate, Liverpool.
2449 Electric Railways, Orren Allen, London.
2452 Apparatus for Screening Coal, Charles Havilock, Mowll, London.
2456 Metallic Stuffing Box Packing, F. Oswald Franke, London.
2466 Gas Engines, Eduard Quack, London.—[Complete Specification.]
2467 Steam Engines, Thomas William Cole, London.

February 20.

2481 Drawing Pens, Elisha Aver, Manchester.
2484 Railway Couplings, William Lear, William Frank Lear, and George Conway Foot, Bristol.
2494 Taper Gripping Vices, Joseph Samuel Laycock Ashforth, Sheffield.
2496 Ventilators, Henry Thomas Johnson, Manchester.
2518 Boiler Flues, George Lansell, London.
2519 Equalising Strain on Winding Gears, George Lansell, London.
2523 Lubricating Apparatus, George Frederick Redfern, Middlesex. (C. T. L. Sörensen, Denmark.)
2524 Metallic Packing, George Frederick Redfern, Finsbury. (Ernest Hulburd, France.)
2525 Arc Electric Lamps, Charles Richardson, Manchester.

February 21.

2536 Screw-Propellers, Stephen Alley, Glasgow.
2540 Feed Cutters, Herbert John Allison, London. (Stanley Singleton Stout and Harold Green Underwood, United States.) [Complete Specification.]
2541 Railway Chairs, Thomas Williamson, Rutherglen.
2542 Compressed Air and Water Motor, John Howard Rose, Dublin.
2549 Refrigerating Apparatus, Franz Windhausen, London.
2565 Bridges of Puddling Furnaces, Edward James Harris, Birmingham.
2571 Car Couplings, Alfred Julius Boult, Middlesex. (Perry Brown, United States.)—[Complete Specification.]
2572 Valve Mechanism for Air Compressors, William Phillips Thompson, Liverpool. (Edwin Reynolds, United States.) [Complete Specification.]
2578 Keys for Securing Rails Vivian Bolton Douglas Cooper, London.
2585 Forced Draught, Andrew McInnes, Glasgow.
2589 Compound Expansion Engines, James Plaister Harriss-Gastrell, Chancery Lane, London.
2590 Gas Engines, Arthur Charles Sterry and John Sterry, London.
2598 Safety Car Couplings, Alexander Hodgson, London.

February 22.

2627 Grease Injector, Philipp Hubert, London.—[Complete Specn.]
2628 Compressed Fuel, Owen Bowen.
2632 Portland Cement, James Roberton and John Alexander Patrick, Glasgow.
2633 Metal Tubes, James McGhie, Glasgow.
2640 Rotary Engines, James Newlands Miller, Joppa, Midlothian.
2668 Governing Starting and Stopping Steam Engines, James Grafton Jones, London.
2671 Manufacture of Corrugated Tubes, Charles Denton Holmes, London.

February 23.

2688 Cast Plates for Boilers, John Rankine, North Shields.
2692 Miners' Safety Lamps, Norman Macfarlane Henderson, Glasgow. [Complete Specification.]
2696 Turning Large Steam Engines, Andrew Betts Brown, Glasgow.
2707 Friction Dynamometers, George Edward Coupe, London.
2711 Regulating and Controlling Draughts, James Gowland, Leeds.
2732 Steam Cock, William Birch, London.

NOTICE TO NEWSAGENTS AND SUBSCRIBERS.

Numerous complaints having been made to us by Subscribers of the difficulty they experience in obtaining copies of the *Practical Engineer* in certain districts, we have to state that the Journal can be obtained by any Newsagent through the ordinary trade channels, and no difficulty should therefore exist in obtaining copies by order of any Newsagent.

For the information of the trade, we may state that copies can be obtained from either of our Offices in London or Manchester, or from any of the following wholesale houses, who are also supplied with Contents Bills for the use of the trade:—

W. H. SMITH & SON, Strand, London.
W. H. SMITH & SON, Blackfriars Street, Manchester.
JOHN HEYWOOD, Deansgate, Manchester.
ABEL HEYWOOD & SON, Oldham Street, Manchester.
J. MENZIES & CO., Hanover Street, Edinburgh.
J. MENZIES & CO., Drury Street, Glasgow.
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&c., &c., &c.

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EDITORIAL NOTICES.

All communications for the Editor of this Journal should be addressed to 6, Victoria Station Approach, Manchester.

Communications intended for insertion in the current week's issue should reach us not later than Tuesday Evening.

We cannot undertake to return rejected manuscripts or drawings unless accompanied by a stamped and directed envelope.

Contributors are requested to write on one side only of the paper. Sketches should be sent on separate sheets.

TO ADVERTISERS.

Advertisements intended for insertion in the current issue should reach us on Wednesday morning at the latest.

Important Notice to Newsagents and Subscribers.

Our Publishing Offices in London are now at 11, PATERNOSTER BUILDINGS, E.C., where the Trade will in future be supplied.

Simultaneously with the above change, our PUBLISHING OFFICES in MANCHESTER have been REMOVED from Grosvenor Chambers, Deansgate, to more commodious and convenient premises at 6, VICTORIA STATION APPROACH, where all communications intended for the Manager or Editor should, in future, be addressed.

THE
PRACTICAL ENGINEER.

MARCH 9TH, 1888.

THE LISTOWEL AND BALLYBUNNION RAILWAY.

THE opening of the Lartigue Railway, running between Listowel and Ballybunnion, Ireland, a distance of ten miles, an account of which appears in another column, is a matter of very considerable interest to railway engineers. This system of railway construction has now passed beyond the experimental stage, and has assumed a practical shape, and its working will now be eagerly watched and compared with the ordinary double-line system. The peculiarity of the system is that there is but a single line on which the engines and carriages run. The line is raised on standards about 40in. above the floor level, and the locomotives and carriages are suspended by means of central wheels, the greater part of their bulk hanging below the rail, so as to be in stable equilibrium. Side wheels are provided to prevent oscillation. The locomotive has two boilers, one on each side the line, and the engine is fixed between them. The tender is of a novel construction, being fitted with steam cylinders and gear for giving increased driving power, and assisting the locomotive on short, steep inclines. This gear can be brought into action instantaneously by the driver without interfering with the speed of the train, and it is calculated that the boilers will supply the additional steam required by the tender's cylinders for runs up to a mile in length. The maximum pressure of steam carried in the boilers is 150lb., and the weight of the engine in full working order is only 6½ tons, while that of the tender is 4¼ tons. On the line just opened in Ireland the rolling stock at present consists of three locomotives; three first and four third class passenger carriages, measuring 16ft. long inclusive of buffers, 8ft. wide, and accommodating from 20 to 24 passengers each; two covered goods vans; two guards' vans, with third-class compartments attached; two open goods wagons; two cattle trucks, convertible into trucks for carrying sheep and pigs by inserting an intermediate floor; and one horsebox, with a third-class compartment attached. The trucks and wagons are a foot wider than the passenger carriages, but of the same length; they will carry four tons of goods. The passenger carriages are arranged internally in two ways; some are made to seat passengers with their backs against the rail, while others are arranged for the passengers to face one another in the ordinary way.

The locomotives were built by the Hunslet Engine Company, and the carriages and wagons by the Falcon Engine and Car Works, Loughborough. The carriages and goods vans are fitted with the Westinghouse brake, and by means of a connecting pipe a mixed train of passengers and goods can have a continuous brake applied. The crossings, switches, and turntables are made on the same principle, and are about 25ft. in diameter, so as to admit of an engine and tender being turned at the same time. The whole of the permanent way is of steel, manufactured at the works of Mons. Achille Legrand.

THE NAVY ESTIMATES.

THE Navy Estimates have been presented to Parliament this year with a degree of completeness and clearness never before attained, and we think the House of Commons will have little difficulty in ascertaining, not only the cost of each branch of the service, but the chief items of which the total is made up; and, what is also very desirable, the House will be able to effect a real control over the expenditure. The decrease in the estimates, as compared with those of last year, amounts to £905,581, largely due to reforms in dockyard administration, and in a lighter degree to the efforts of the Admiralty Board to finish, as soon as possible, the shipbuilding programmes of former years before embarking on a fresh one. As an instance of this, a saving in labour on the Trafalgar and Nile has been effected to the tune of £40,000 each, and still the rapidity of construction has rivalled the best record in private shipbuilding yards. We should think that even a greater saving may be expected after the disclosures from Keyham (mentioned in a note in this issue) have been thoroughly sifted, as it is quite evident that the public money has been something more than wasted in the Government yards. The First Lord's description of the Blake and the Blenheim—two new first-class cruisers that are intended to surpass in speed, coal endurance, protection, and armament anything hitherto attempted—will be of absorbing interest to warship engineers. Their displacement will be 9,000 tons; speed 22 knots on the measured mile, and 20 knots in continuous steaming, and at a 10-knot speed their radius of action will be 18,000 knots. Their armament will be 9·2in. 22-ton bow and stern chasers; a broadside of ten 6in. 5-ton quick-firing guns; eighteen quick-firing 3-pounders, and four torpedo tubes. The protection will consist of a steel deck of 6in. maximum and 3in. minimum thickness, extending throughout their length and over the machinery. There will be no side armour. This latter feature, we should expect, will raise a warm controversy in the House of Commons.

ON VARIOUS TYPES OF ENGINES.—I.

An inquiry as to the most suitable type of engine for any particular class of work, if put to half a dozen different persons, would probably elicit almost as many different replies; and as the question is one that not unfrequently arises, a review of the peculiarities, advantages, and disadvantages of the various kinds of engines most in vogue may be interesting.

The one principal requirement looked for in the vast majority of cases is that the engine shall work economically as regards expenditure of steam. There are, however, cases where economy is subordinated to some other special requirement, such, for instance, as where the work is intermittent and variable, and where handiness and reliability in starting, stopping, or reversing are necessary, as with colliery winding engines. In other cases compactness, where space is limited, or portability may be an important item. Again, some kinds of work, requiring the power to be given off in a certain position, may necessitate the use of a special type of engine, as, for instance, in a steamship propelled by a screw, where direct-acting engines alone can well be adopted. In the generality of works, however, the choice is not thus limited, and is governed by economical considerations only. Accessibility, for overhaul and adjustment of the various parts, is a desideratum that should not be lost sight of.

Engines generally may be divided into two classes—the beam and the direct-acting. The latter may be subdivided into those having horizontal and those with vertical cylinders; and again, of both classes there are single-cylinder and compound engines.

The improved beam engine, as left by Watt after the introduction of the crank and the parallel motion, has rendered splendid service to the last and present generations, and it is doubtful if any other type of engine can be shown to be so durable, to require so little attention while working, to be so economical in the matter of lubrication, and to cost so little from wear and tear. It is, however, not so well adapted to the higher pressures and increased speed now considered necessary to obtain the greatest economical results as are direct-acting engines, and in spite of its grand record this old pioneer is now to a great extent becoming obsolete. The number and weight of the working parts, the fact of the beam (through which all the power is transmitted) being subject to a bending moment, and the greater destruction that usually results in case of breakdown, all tend to render the beam engine less suitable to withstand the shock and strain of a high initial pressure than the direct-acting engine, and necessitate a more gradual admission of steam to the cylinder. The long connecting-rod—an advantage in other respects—with its greater momentum, requires to have great rigidity and weight, and limits the safe speed at which the engine can be run.

The advantages derived from the high speed attainable with an engine of short stroke and having a short connecting-rod may be briefly stated to be—diminished loss from cylinder condensation, greater regularity of turning, and that the work can be done by a smaller engine.

The strain on the beam is to a great extent relieved by placing a cylinder on each side of the centre, as in the McNaught plan of compounding; and a further improvement has been effected by using wrought iron in lieu of the old cast-iron connecting rod. Thus further improved, beam engines may be worked up to a fair pressure, and may be found running at a piston speed of 600 feet per minute, but these are exceptional cases, while with direct-acting engines higher pressures and speed are available. The proportion of power required to overcome friction probably attains its minimum in the beam engine. The whole weight of the working parts is borne by the beam centres, where the extent of motion and, proportionately, the friction are greatly reduced, and to this fact may be credited to some extent the freedom of the engine from the ravages of wear and tear. All parts of the engine are also fairly accessible. The noble appearance of the machine, too, as compared with its less pretentious rivals, although a matter of minor importance, undoubtedly has some effect in recommending it to favour.

Of direct-acting engines, the horizontal has hitherto taken the lead in public esteem. Its compactness, the fact of its being self-contained, and requiring no special building of great strength to support it, together with the advantages above described as appertaining to direct-acting engines in the matter of high speed and pressure, render it a useful machine and available under most circumstances. Its principal drawbacks arise from the horizontal position of the cylinder, which necessitates increased lubrication, and causes unequal wear of the most important part of the engine. The result of this in a long-stroke engine that has been at work for some years, and the consequent deviation of the piston-rod from its direct line of motion, even where guides are provided at both ends of the cylinder, may be noticed from the working of the rod in the glands, and the wear in the lower half of the bushes. Increased liability to piston leakage and a tendency to leak and draw in air at the glands, with their attendant evils of vitiated vacuum and decreased economy, are thus induced. To reduce the wearing of the cylinder, the piston is sometimes made with a large bearing surface, by casting a wide flange or shoe on the lower side. Another plan, which we believe has been tried with some success, is to bend the piston-rod slightly in form of a bow, with the concave side uppermost, to such a curve as will cause the rod to assume a straight position when the weight of the piston is placed on it. There would, however, appear to be considerable difficulty in attaining such a curve sufficiently correctly. Another effect of the horizontal position is seen in the side wear, in addition to the wearing in a downward direction of the brasses of the crank-shaft bearing. This is only partially counteracted by the use of the diagonal or what is commonly known as the swan-neck pedestal, but of late years an improvement has been effected in this respect by having the bearings made with four brasses, with side adjustments. Further improvements have also been made in the design of the engine, the centre-line form of framing being now generally adopted by the best makers, in preference to the old form of bedplate placed entirely below the engine. Much straining and springing are thus obviated.

TRANSMISSION OF POWER.—V.

ROPE-DRIVING.

The V-shaped rope grooves in the pulleys should be turned accurately to the same size, but this is often neglected, the result being that the ropes sink lower in some grooves than in others, and, consequently, have a less working radius, and therefore some are stretched more than others on the one side and slackened on the other, and in extreme cases the removal of a rope actually relieves the remainder.

To test the accuracy of the grooves, fit a thin piece of wood to one groove exactly, lay a straight edge across the top of the groove parallel to the shaft, and mark off. If the gauge thus made sinks to exactly the same depth in the other grooves, the pulley is satisfactory, but many pulleys show a considerable variation.

The driving-ropes, whether of hemp or cotton, should, if possible, be all made at the same time, and, consequently, of exactly the same size. The ropes stretch a little in working, and thus decrease in diameter, and new ropes should be of the original size, as, if made of the working size, when stretched by working they will be of less diameter than the original ropes, and will work lower in the grooves, with bad results if the pulleys are of unequal diameters, as is generally the case.

The sides of the grooves make an angle with each other approximating to 45°, more or less, according to the usage of the different engineers, and the bottom is turned out to a smaller radius than that of the ropes, so that the latter do not touch the bottoms of the grooves, but grip the sides.

The splices of the ropes are either weaker or thicker than the body of the rope, and in one case break before the rope is worn out, or in the other cause unsteady running. Ropes should be carefully watched, and their defects at once remedied. It is at all times difficult to ensure that each rope works with the same tension.

THE BOARD OF TRADE AND THE BOILER EXPLOSIONS ACT, 1882.

As we intimated some time ago, there are indications, now that the above Act has been a sufficiently long time in operation for steam-users generally to have learnt their responsibilities under it, that its provisions and the penalties under it will be more strictly enforced in the immediate future than they have been hitherto. At the monthly meeting of the Failsworth Local Board, on Thursday last, a communication was read from the Board of Trade, calling attention to the conviction of the owner of a steam boiler for having neglected to comply with the provisions of the Boiler Explosions Act, 1882, by not reporting an explosion which occurred on his premises. The letter further stated: "The Board have reason to believe that many owners of steam boilers are still unacquainted with the requirements of the Act, and that consequently cases of explosions sometimes occur which escape the investigation provided for by the Act; and as nearly all explosions arise from preventible causes, it appears to be very desirable that in every instance an inquiry should be held, and a report thereon published."

It was resolved to draw the attention of owners of steam boilers in the township controlled by the Local Board to the requirements of the Act.

There is little doubt that a vast number of boiler owners are unaware that in the event of an accident to their boilers which can by any straining of terms be denominated an explosion, the boiler owner or some person acting on his behalf is requested under Section 5 of the Act to send notice to the Board of Trade within twenty-four hours thereafter, in default of which they are liable to a fine not exceeding £20.

We have reason to know that in most of the cases where failures have occurred of insured boilers, the owners have only learnt their liability after communicating with the Boiler Insurance Company. What adds to the difficulty in these cases is the fact that nowhere in the Boiler Explosions Act itself is there any definition of what constitutes a boiler explosion, and when such trivial occurrences as fracturing of steam pipes and fittings, fusion of fusible plugs, &c., and numerous other slight disarrangements to which boilers and their fittings are always liable, are dignified with the name and invested with all the importance of a boiler explosion, and made the subject of a preliminary inquiry by a Board of Trade official, it is not to be wondered at if some confusion should exist in the lay mind as to which kind of occurrences come under the category of "explosion."

One unfortunate result of this absence of definition of the term "explosion" is, that many really serious cases of overheating and collapse of furnace tubes, &c., have occurred, which, through their not being accompanied by rupture and violent escape of the contents of the boiler, have been considered not to be cases requiring investigation under the Act, and no notice has in consequence been sent to the Board of Trade.

It is, in our opinion, far more important where a large ironworks boiler, for example, fired by gases from a heating furnace or blast furnace, is allowed to become short of water and the tube collapses—though owing to its being constructed of good and very ductile material rupture does not take place and a most serious disaster is thus narrowly averted—that such a case should be investigated and the cause of failure ascertained, than that such a trivial matter as the fracturing of a feed valve or the breaking of a glass water gauge, which can cause little or no damage, should be the subject of grave official inquiry. More than one instance has come under our own personal knowledge where collapse has occurred from shortness of water, &c., but unattended by explosion, under circumstances where the loss of life and damage to property, had the collapse been accompanied by rupture of the overheated plates, would have been something appalling; and yet it has been considered that such cases did not come within the category of those requiring investigation under the Boiler Explosions Act, and no notice has accordingly been sent to the Board of Trade.

Should the effect of the removal of the late President of the Board of Trade be to cause the proposed bill dealing with this subject to be dropped, and the recommendations of some of the chambers of commerce who have made pronouncements upon this question be acted upon, and an attempt made for a time to still further diminish boiler explosions by enforcing more strictly the provisions of the Act now in force, it would appear to be to the interest of everybody concerned, steam users and public and Government officials alike, that an additional clause should be inserted, defining clearly the cases which should be considered fit subjects for investigation.

NOTES.

At a special general meeting of the shareholders of the Mersey Railway Company, held last week in London, the Right Hon. E. P. Bouverie, the chairman of the company, stated that the Mersey Tunnel, which had cost over two millions, had unfortunately proved unremunerative, and did not pay interest on the preference stock. It was now sought to raise half a million in preference stock to complete the junction with the Central Station at Liverpool with the Cheshire, Great Western, and Southern Railways at Rock Ferry, and afterwards with Birkenhead Docks and the Lancashire and Yorkshire Railway. The traffic between the Cheshire side of the Mersey and Liverpool was immense. All traffic to the Cheshire residential district must be taken either by tunnel or by ferries, as there was no tram or bus competition. He thought the tunnel would beat the ferries.

He regarded the railway as destined to become a mighty and prosperous concern, especially when goods traffic was added to the passenger traffic. A resolution favouring two bills now before Parliament in connection with the Mersey Railway was, after some opposition, carried by a large majority.

A scandal of the gravest kind has just been disclosed in connection with the Devonport Dockyard. A raid was made on Monday on the coppersmiths' shop, Keyham Dockyard, by the police, and serious disclosures have been made. About fifty men, it is said, have been placed under arrest. It is alleged that, not only have the suspects been working on other than their proper work during Government hours, but that their handicraft, contrived out of Government stores, has found its way to outside firms, and some, it is stated, even to official residences. Furthermore, it is alleged that there has been wholesale trafficking going on between certain Birmingham firms and certain of the men, the method employed being that the former have sent inferior goods to the latter to be plated, and after the illicit work has been successfully performed, the articles, improved at the expense of the ratepayers, have been smuggled out of the gates. Already it has been discovered that serious inroads have been made in the stock of tin kept for plating purposes, and the number of copper kettles and other articles seized on Monday is said to be prodigious.

ASSOCIATED CHAMBERS OF COMMERCE AND THE BOILER REGISTRY BILL.

The third and concluding meeting of the Annual Session of the Associated Chambers of Commerce was held at the Hotel Metropole, on Thursday, the 23rd ult., Sir Bernhard Samuelson, M.P., presiding. The following resolution had been placed on the paper by the Oldham Chamber :—

"That this Association is strongly opposed to the Boiler Registry and Inspection Bill, 1887 (introduced into the House of Lords by the President of the Board of Trade last session), which they consider unnecessary, as shown by the rapid diminution of accidents which have taken place during the past few years, and as only likely to further embarrass trade already sufficiently harassed by Parliamentary enactments, and would call attention to the Boiler Explosions Act, 1882, the powers under which already conferred upon the Board of Trade, if put into force, are amply sufficient to act as a safeguard against accidents, and as a deterrent to carelessness on the part of owners of boilers."

This was strongly opposed, and eventually negatived in favour of an amendment to the effect that the meeting, without pledging itself to all the details, approved the principle of the measure referred to, as the Act of 1882 had not been a sufficient safeguard against avoidable accidents.

OPENING OF THE LARTIGUE RAILWAY IN IRELAND.

The Listowel and Ballybunnion Railway was on the 1st inst. formally opened under gratifying circumstances. M. Lartigue, the inventor, was himself present, and he has every reason to be satisfied with the inauguration of this the first attempt to apply his invention to the practical purposes of ordinary railway traffic. The single-rail system is not a mere toy novelty. It has now been proved to be a thoroughly practicable invention. Although specially applicable to short-distance railways, there is apparently no reason why it should not be utilised also for more extended lines. One great advantage of the system is its cheapness of construction. The line of ten miles which has been laid between Listowel and Ballybunnion, has been equipped for the moderate sum of £30,000, or £3,000 a mile. This total includes the cost of the land taken over. In this instance the construction has been accomplished under exceptionally unfavourable circumstances. Ballybunnion is one of the most remote parts of Ireland, and the cost of conveyance of the rails and rolling stock has been unusually heavy. A rough estimate puts the cost of freight and railway carriage alone at about one thousand pounds; and Mr. Behr, the managing director, to whom the success of the application of the system to this practical industrial undertaking is mainly due, states that the materials could have been conveyed more cheaply to the Brazils than to Listowel. A very large portion of the materials, nearly the whole of which had to be imported either from England or the Continent, had to be carried by rail from Waterford to Listowel, via Limerick; while even in the case of that which could be brought by sea to Fenit, the nearest pier, it had still to be carried over twenty-seven miles of railway. A further difficulty had to be encountered in the fact that the route of the line passed for a considerable portion of its extent through a bog, the drainage of which entailed much additional labour. The amount of traffic over the line can at present be only a matter of speculation, but with the seemingly very moderate estimate of three thousand a year, the profit, after defraying working expenses, would be about £1,500, or 50 per cent. Should the receipts amount to the not very extravagant sum of £5,000 a year, the working expenses would then amount to only 35 per cent. The financial success of the undertaking therefore seems assured, and now that much valuable experience has been gained, it is calculated that similar lines could be constructed and equipped for £2,500 a mile.

The inaugurating party, after a brief examination of the rolling stock and the general station arrangements, took their seats in the train of seven or eight carriages, and a start was effected without delay, and the first general passenger train ever conveyed over a practical working single-rail line went smoothly on its way. The movement was exceedingly smooth, even when the train was at its highest speed; in this respect comparing favourably with the motion of trains on ordinary railways. The "level" crossings formed of a gate, consisting of a section of the line, were objects of great interest. They are most ingeniously constructed. The opening of the gate raises a danger signal, which only disappears when the gate has been securely closed again and the continuity of the line restored. The key, by an ingenious arrangement, is itself, as it were, "locked in" while the gate is open, and can only be withdrawn by the farmer who owns it when the gate has been locked. The bridges attracted scarcely less attention, especially the automatic arrangement by which the danger signal is raised alike in the day time and at night. The night signal is a red lamp, the light of which remains visible until the bridge has been completely raised and the line accordingly clear. Ballybunnion having been reached, the party spent a short time exploring the caves on the coast, which are of the most interesting character. After lunch the party returned to Listowel, the journey, exclusive of stoppages, being performed in thirty-eight minutes. It is intended to apply to the Grand Jury of Kerry Assizes, which opens on Monday next, for a baronial guarantee for the construction of a line, or rather the extension of the same line, to Ballylongford and Tarbert.

THE ELECTRIC LIGHTING ACT.

In moving the second reading of the Electric Lighting Act (1882) Amendment Bill in the House of Lords, on Monday, Lord Thurlow explained that the object of the measure was to remove the prohibitions and restrictions in the use of the electric light in private houses, the attainment of which object would, he asserted, develop the electric lighting industry to such an extent as to give employment to 150,000 or 200,000 persons. He pointed out that there were 120 electric lighting companies in the United States, which during the past three years had paid an average dividend of 11 per cent. The industry might be made equally profitable in this country if it were developed so as to bring the electric light into factories, mines, schools, churches, theatres, and so on. The bill would extend the life of a Board of Trade provisional order from 21 years to 42 years.

Lord Salisbury agreed that it was not creditable to this country, looking at the amount of capital we had lying idle, that so little progress had been made with electric lighting; but at the same time it must not be forgotten that we had had severe experience of the results of leaving municipal authorities and gas and water companies too much at liberty to make their own terms with the public. Water companies had bound Parliament to conditions which might never be got rid of, and which very seriously affected the progress of the sanitary measures which were so much required in several parts of the metropolis. He did not know that we were much better off as to gas, the companies having secured terms which if their results could have been foreseen by Parliament would have led to the acts being very seriously modified. It was not unreasonable, therefore, that in dealing with the new element of electricity they should proceed with some amount of caution. He agreed that in attempting to get as good terms as possible for the public they had prevented their getting electric lighting at all. As to the noble lord's bill, no feeling of self-love would prevent them from accepting it.

The bill was read a second time.

LESSONS IN MECHANICAL DRAWING.—XIII.

Fig 72

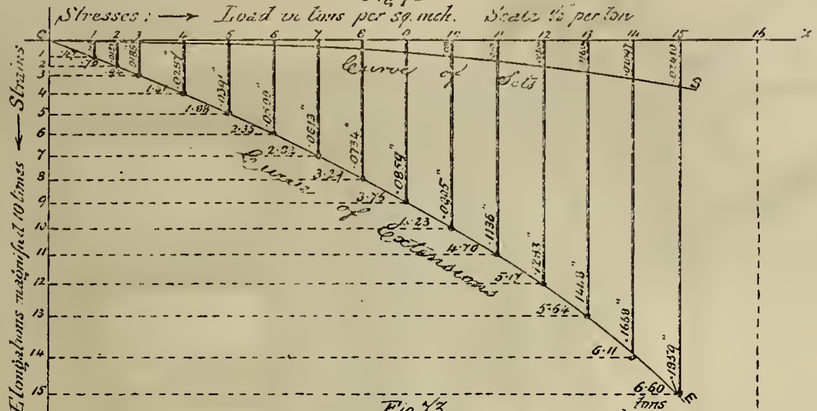
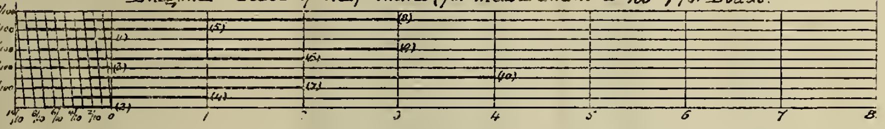


Fig 73

Diagonal Scale of Half Inches (for measurements to $\frac{1}{100}$ths) for Loads.



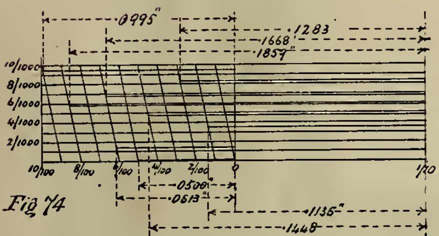


Fig 74

Diagonal Scale for Elongations and Sets (magnified 10 times)

The above are the illustrations which should have accompanied the article in our issue of last week. The article, on being read again in the light of these figures, will, we trust, be more intelligible than it was before.

THE WORK LOST TO ENGLAND.

Some ingenious soul with a turn for tables of statistics might draw up a singularly valuable and interesting paper on the work lost to England through adverse foreign tariffs and insular foolishness. In the heyday of our prosperity, when wealth rolled in like a flood, British manufacturers were too prone to present a stiff lip to any strangers who suggested a new pattern or a novel style. It was largely through this shortsightedness that the United States manufacturers obtained command of the Australian markets, as well as the West, in axes, adzes, saws, spades, forks, and other tools and appliances which English makers, after adversity had suffered the scales to drop from their eyes, set themselves to imitate. That they reconquered so many lost markets was exceedingly creditable to their stubborn determination not to be beaten. There is no feeling that way now. No longer is the Colonist told he must take the tools English makers think best for him. The drift is all the other way. English firms invite the Colonists to suggest changes and improvements, and send representatives to take their ideas at first hand. Foreign tariffs are now the difficulty, though foreign labour, long and cheap, is also a factor in the fight. Nottingham firms have stockings and lace made in Saxony and Germany; Stockport has its "Silent" gas engines made in Ghent; Deepcar (Fox and Co.) its paragon frames made in France; and so the list might be extended. Our warehouses are full of German nippers and other German and American hardware, while English artisans walk moodily about the streets, or try, as at Sheffield, with bleeding and blistered hands, to level themselves down from handicraftsmen to labourers and stone breakers at eightpence a day. Who is to be the man to solve the problem of the unemployed—to win back the lost industries of the land, and to widen the sphere of labour for those who earn a living more by the skill than the strength of their hands?—*The Engineer.*

*

FILTRATION OF WASTE OIL.

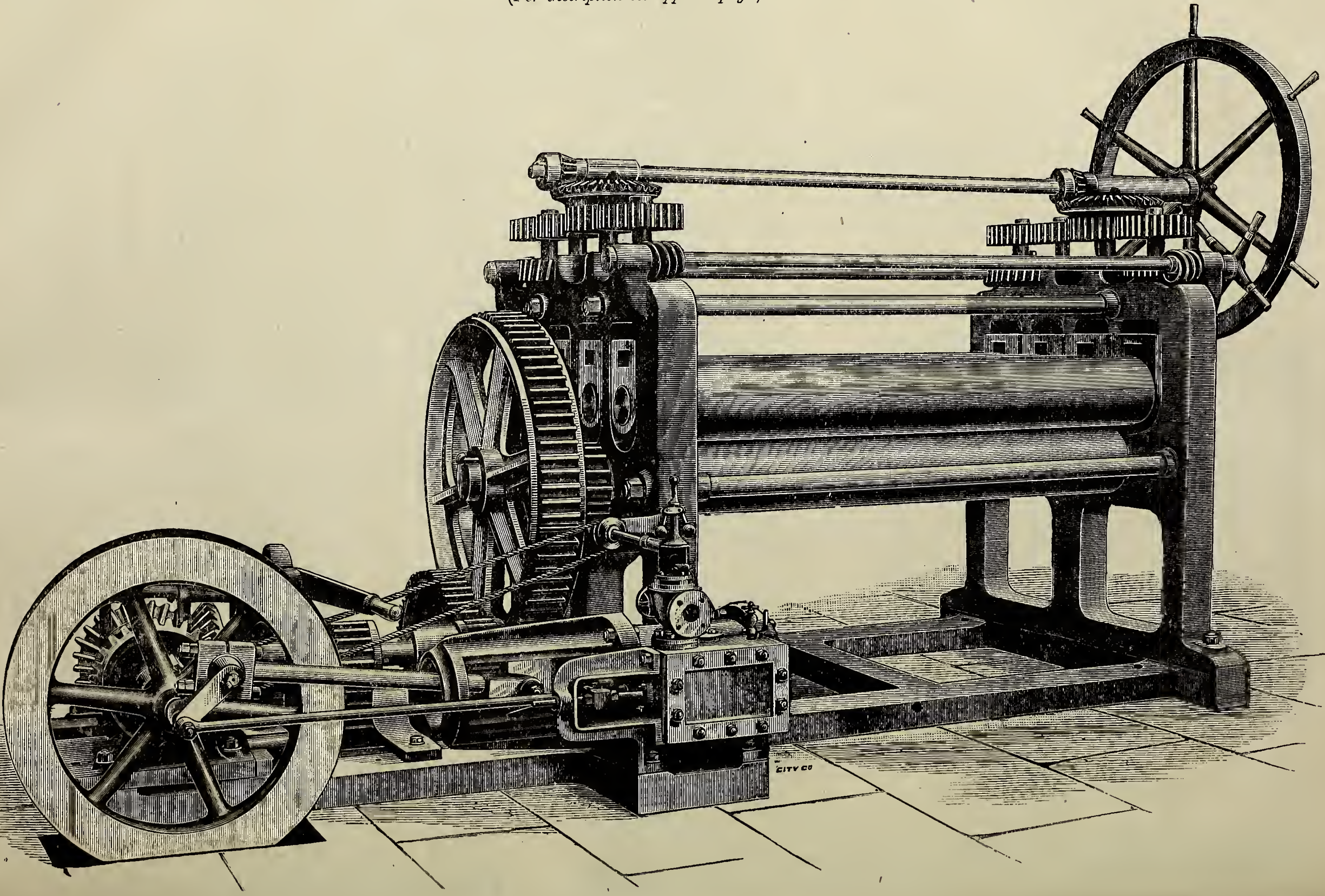
The exact nature of the functions exercised by molecules of oil in lubricating surfaces, like many other physical questions, merely leads to hypotheses, without any exact solution which determines what is lubrication. From extended experiments and observations upon the subject, the conclusion has been arrived at that oil in lubrication never "wears out." Its lubricating properties are impaired by holding dust and metal in suspension, by volatilisation of the more fluid portions, and by oxidation, but the remaining portion of the oil still performs its original function. The lack of knowledge on the subject of lubrication pertains how to use oil rather than what oil to use. The separation of oil dripping from heavy journals is easily performed by filtration through a cask of sand or charcoal, with a piece of cloth at the top to remove the coarser impurities. If the lard or sperm oil used has "gummed" to a considerable extent, an admixture of mineral lubricating oil will dissolve much of the thick material, and improve the character of the filtrate as a lubricant. The fluidity of oil is so much greater at high temperatures, that this process is much more satisfactorily accomplished at a temperature of 100 deg. Fahr., and a steam coil may be used to advantage, or the filter may be placed in some warm place; in either case the hazard of fire from spontaneous ignition or from the inflammable vapours arising from the oil must be guarded against by carrying on the work in some cheap shed or suitable place where fire would not result in disastrous consequences. Oil is removed from metal turnings by means of a centrifugal extractor which is surrounded by a steam jacket, and the oil thrown out by the extractor is ready for use on cutting tools, but should be filtered before being used for lubrication. The first centrifugal extractor was designed for the purpose of separating syrup from granulated sugar in the process of sugar manufacture, but to the disappointment of the inventor its use was satisfactory only for a few minutes, after which the syrup would gum upon the perforations in the sides of the revolving cylinder, and prevent its further operation. Numerous expedients in the way of scrapers and other mechanical devices did not remove the difficulty, until a bystander casually remarked that a jet of steam would allow the syrup to flow continuously, and this suggestion led the way to successful operation of the machine.—*Engineering.*

Institute of Mechanical Engineers.—The summer meeting of the Institution of Mechanical Engineers will this year be held in Dublin, an interval of twenty-three years having elapsed since the previous meeting in the capital of Ireland. The Provost and Senior Fellows of Trinity College have obligingly offered every facility and accommodation in their power, and the members will thus enjoy a renewal of the hospitable reception which was accorded them on the occasion of their former visit. The meeting will commence on Tuesday, July 31st, and will last four days.

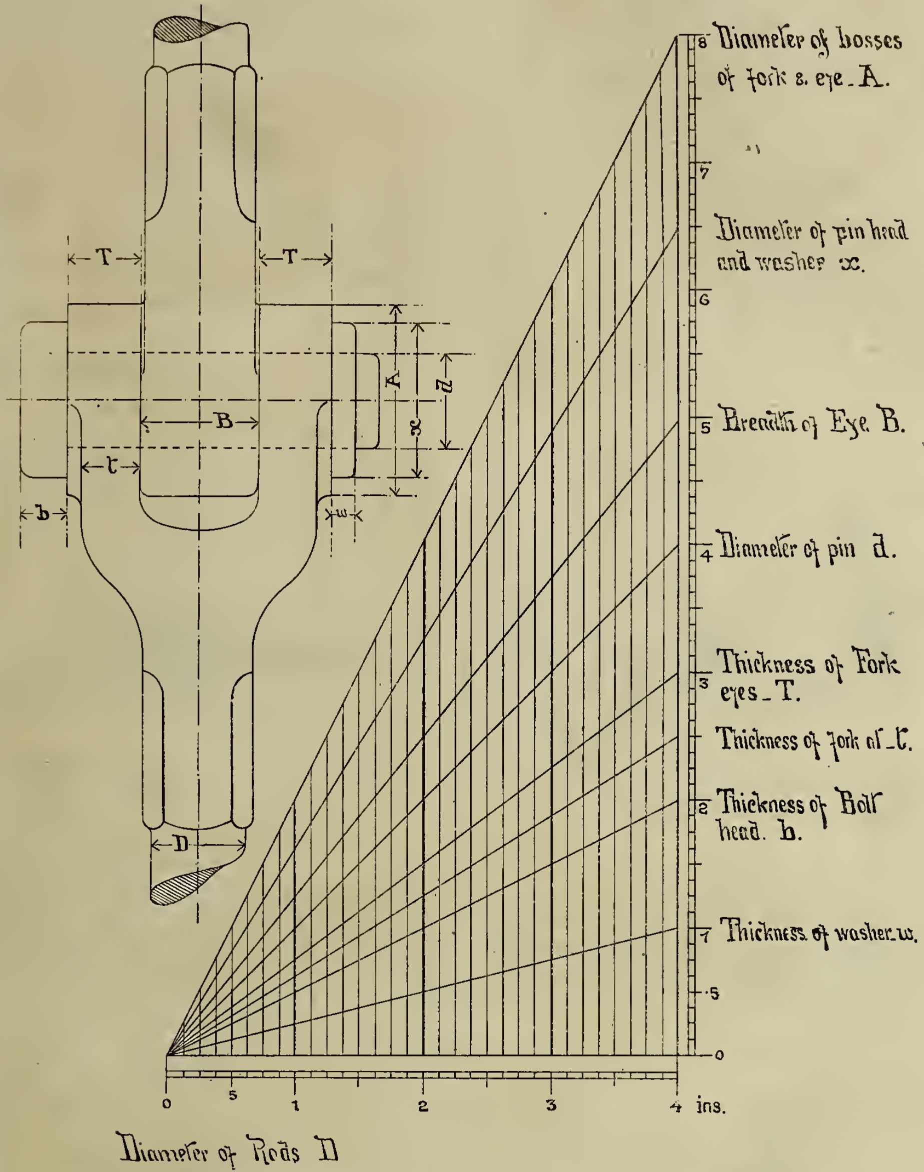
PLATE-STRAIGHTENING MACHINE.

CONSTRUCTED BY MESSRS. FRANCIS BERRY AND SONS, ENGINEERS, SOWERBY BRIDGE.

(For description see opposite page.)



PROPORTIONS OF FORK JOINTS.


T
T
B
A
x
d
t
b
w
D
8 Diameter of bosses of fork & eye - A.
7
Diameter of pin head and washer x.
6
5 Breadth of Eye B.
4 Diameter of pin d.
Thickness of Fork eyes - T.
3
Thickness of fork at - t.
2 Thickness of Bolt head. b.
1 Thickness of washer w.
·5
0
0
5
1
2
3
4
ins.
Diameter of Rods D

THE diagram herewith will be useful in designing fork joints for rods up to 4in. diameter. As the figures are self-explanatory, it will be unnecessary to add anything more to this note.

PLATE-STRAIGHTENING MACHINE.

THE full-page illustration in this issue represents a self-contained plate-straightening machine of very large proportions, for dealing with plates up to 6ft. wide and $\frac{9}{16}$in. thick. There are seven rollers, the upper four being adjustable for height by the hand wheel and gear shown in the illustration. All four rollers can be raised and lowered together, or the two outside ones may be adjusted separately by worm wheel gear. The engine for driving the machine has a 10in. cylinder, and is governed by a high-speed governor. The gearing is very powerful, and conveys the motion to the lower rollers through three steel pinions keyed respectively on their ends. The machine is mounted on a strong cast-iron bedplate extending the whole length of machine and engine, so that very little foundation is required. The total weight is 12$\frac{1}{4}$ tons. It will be noticed that the engine is placed entirely to the left of the machine, and the hand wheel for adjusting the rollers is at the right end, so that the workman runs no risk of being caught in the gearing whilst regulating the rollers. The makers of this powerful machine are Messrs. Francis Berry and Sons, Calderdale Ironworks, Sowerby Bridge, Yorkshire.

ELECTRIC WELDING.

THE following, from the *Electrician*, is a description of Bernardo's method of electric welding, and will be interesting to our readers.

It has been well known for many years that almost all substances are fusible in the electric arc, and Siemens, Wallner, Cowles, and others have done much work in the direction of electric welding by this means, with more or less success.

The principal point in which Bernardo differs from his predecessors is that he makes the metal to be welded *itself the negative pole*, the positive being a carbon rod. The strong reducing action thus brought to bear on the metal keeps it perfectly clean and unoxidised. If the poles are reversed the fluid metal is promptly covered with a layer of oxide, which makes the welding almost impossible, and there is great danger of burning holes. Bernardo uses as a source of current seven sets of accumulators in parallel, each set seventy cells in series. These he charges while working by a thermo-dynamo, giving 120 amperes at 175 volts. He uses special battery plates, made of lead strip, as he has found that "pasted" cells will not stand the heavy charge and discharge currents he employs. The E.M.F. and current required depend on the size, &c., of the work to be done. As an example, to weld together two pieces of $\frac{3}{8}$in. boiler plate, forty cells in series and three in parallel would be taken, one end joined to the plates, and the other by a flexible lead to a 1in. carbon rod, in a portable holder. The metal is then touched with the rod, which is immediately withdrawn from $\frac{1}{4}$in. to $\frac{1}{2}$in., thus striking an arc. The metal at the point where the arc forms melts immediately, like so much wax, and runs perfectly fluid. Through the dark spectacles the arc appears like a blow-pipe flame, and is manipulated much as if it were one. If the effect is too strong, and the metal boils and evaporates, fewer cells in parallel are used; if the arc goes out too often, more are added in series. If heavy pieces of metal of high melting point are to be joined, large currents and E.M.F. must be used, the carbons being proportionately larger, and *vice versa.* The action of the arc is, like that of a blow-pipe flame, very local; only that part of the metal which requires to be melted is much heated, and the moment the arc is removed the fluid metal solidifies. The most refractory metals are instantly liquefied, and the work can be done with great rapidity. The metals to be operated on require hardly any previous preparation, as with the high E.M.F. and currents used even a heavy coating of rust is at once fused. A little sand is used to unite with any oxide not reduced, and the slag thus formed protects the finished part from the oxygen of the air while cooling.

It is a great advantage in Bernardo's method over ordinary welding, that the heat can be so easily taken to the place required, instead of having to bring the metal to the forge. In repairing a boiler, for instance, there is a good example of the extreme simplicity and convenience of the method. The negative lead is attached to any part of the boiler by a small vice on the left hand; and then, by taking the positive carbon-holder in the hand, any part can be operated on.

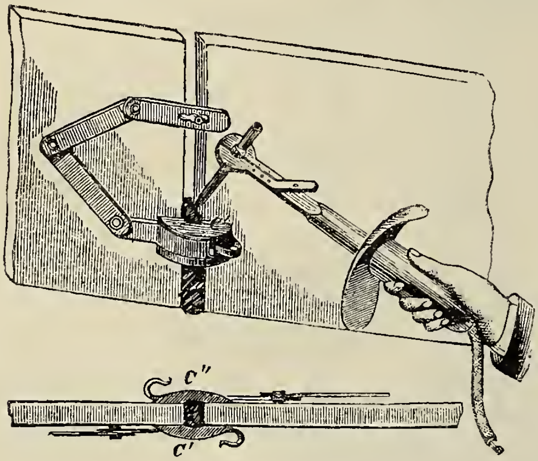


Fig 1

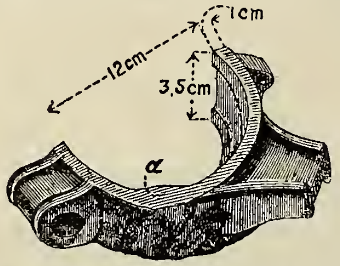


Fig. 2

Besides welding two pieces of steel, wrought or cast iron, &c., together, the process has been used to join with copper, tin, zinc, brass, lead, steel, or cast iron; as also to weld copper and brass, brass and brass, &c., and to coat iron with copper, tin, and lead. It may also be used to cut up as well as join a piece of iron plate, &c., as the metal runs off like water if no means are taken to retain it; and it may be noted that the process may even be used *under water* both for welding and for cutting metals.

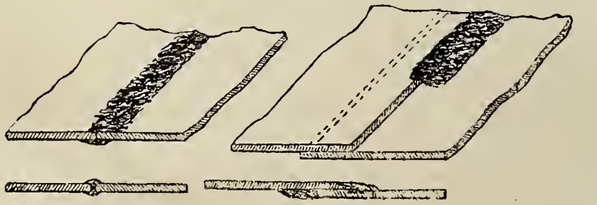


Fig 3. Fig. 4.

Fig. 1 shows the method used for joining two upright plates. *C' C''* are carbon blocks to keep the fluid metal in, and are shifted up from time to time as the joint is made.

Fig. 2 is a cast-iron eccentric strap, which was broken with a hammer at *a*, and then mended by fusing it together with small pieces of rolled iron, a little sand being used as flux. In this figure the dimensions are given in centimetres. In this case the joint is perfect, and neither hard nor brittle.

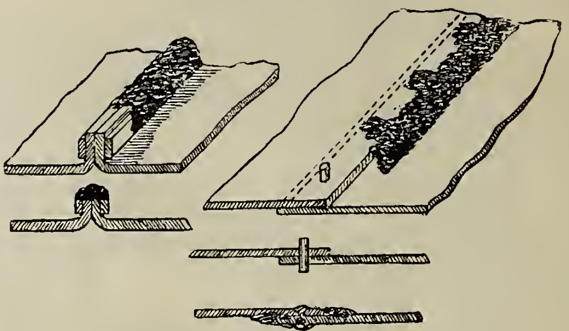


Fig 5.

Figs. 3 and 4 show butt and lap joints, and fig. 5 a pair of plates in process of being electrically riveted. Fig. 6 shows what may be called a "semi-riveted" joint. The upper plate only is punched, and a sort of rivet of molten metal built up in the hole, the edge of the upper plate being welded on the lower in addition. In this figure a piece of iron is shown, which is being fused down to fill up the gap.

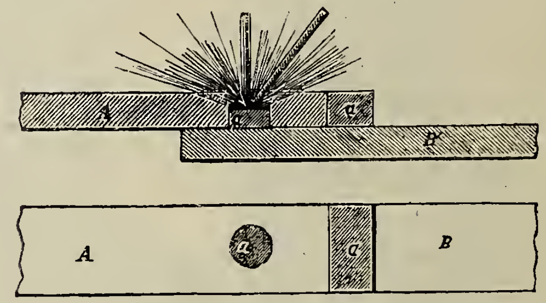


Fig. 6.

Fig. 7 shows two pieces of a thick iron rod being joined, a carbon block being used to retain the molten metal. In this figure also *f* shows a piece of iron being fused down to fill the space.

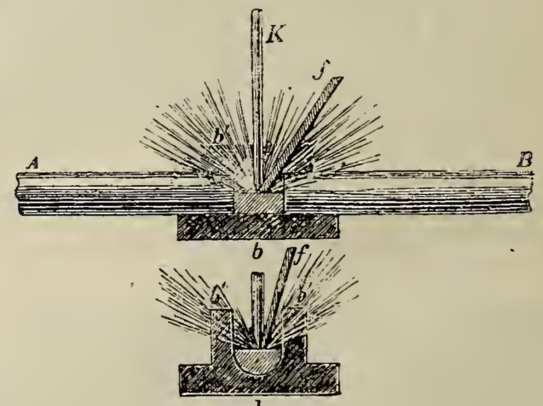


Fig. 7.

Among other uses may be mentioned that of welding fine steel on to a cast-iron body for tools, &c., without any risk of the steel being burned, and for filling up blow-holes which may only have been discovered after a considerable amount of work has been done on a piece of metal.

The Flagship Victory.—The revised estimate for the repair of the Victory, Nelson's flagship at Trafalgar, was despatched from Portsmouth to the Admiralty on Tuesday. The timbers of the ship are, with a few exceptions, as sound as when she was built, but the fir planking which was introduced when she was repaired about 30 years ago is rotten, and will have to be replaced up to the water-line. The cost of substituting teak or oak planking and making the ship good for thirty years will amount to about £10,000.

CARRIAGE OF PETROLEUM AT SEA.

Latterly great improvements have been made in tank steamers, specially constructed for carrying oil in bulk, the most recent of which are embodied in the Ocean and the Chester, sister ships, recently launched by Messrs. Russell and Co., Port Glasgow, to the order of Messrs. Hermann Stursberg and Company, of New York, and the first of the kind which have been built on the Clyde. These vessels are each 310ft. long, and are capable of carrying 3,500 tons of oil, and 300 tons of bunker coal. They are built of steel throughout, and furnished with triple-expansion engines. The machinery space is kept aft, in order that the boilers and furnaces may be shut off entirely from the oil spaces. Immediately forward of the machinery space is a very strong bulkhead, capable of withstanding greater pressure than those built in vessels of the ordinary character, and two feet forward of this again is another equally strong bulkhead. The intervening space is kept clear, so that it may always be accessible for examination, and for the detection of any leakage of oil which may accidentally occur. The remaining length of the vessel, about 200 feet, is divided into 16 compartments, each capable of containing about 220 tons of oil. The whole structure of the ship is triple riveted, by way of preventing leakage, and above the tanks, and running along the 'tween deck spaces, are eight large towers constructed of triple-riveted steel, each containing about 30 tons of oil. These towers are necessary to keep the tanks closely filled, because of the expansion and contraction of petroleum, due to variations of temperature. The pumping arrangements for discharging and filling the tanks are very complicated, and consist of a duplicate series of pipes running fore and aft, and having branches to each of the petroleum tanks. A very powerful Worthington pump is situated in the afterpart of the ship, and this is capable of discharging (taken in connection with the duplicate pipes already referred to) the whole 3,500 tons of oil in little more than 24 hours. During the voyage from this country to New York some of the tanks will be filled with water for the purpose of ballasting the vessel, as it cannot be used for cargo. Oil and water must equally be pumped up so as to fill the tanks to their utmost capacity. Otherwise the washing about of the liquid would introduce a dangerous element of instability, and for this reason glass gauges are placed in the towers so as to insure that a sufficient quantity of liquid is always in each tank. The problem of stability in connection with large masses of liquid on board ship is one of much greater difficulty and intricacy than usual, and in these circumstances Professor Jenkins, of Glasgow University, has calculated the stability and trim of the vessel under varying conditions, and especially with liquids partially filling the tanks during loading and discharging. The calculations show that the vessel is thoroughly stable under loading and discharging, if these operations are conducted with ordinary care. An interesting application of the scientific results thus obtained takes the form of a series of plain rules prepared by Mr. Flannery, the designer of the vessel, and posted in the chart room of the Chester for the guidance of the captain and officers in deciding which tanks may be filled and which left empty, which coal bunkers are to be used and which kept full under the varying circumstances of the trade in which the vessel is engaged. The electric light, it may be added, has been fitted up throughout the ship.

The Earth's Heat.—The earth's heat is being used in a practical way at Pesth, where an artesian well is being sunk to supply hot water for public baths and other purposes. A depth of 8,120 feet has already been reached, and this well supplies daily 176,000 gallons of water, heated to 150° Fah.

High-speed Gearing.—During the last few years, and particularly since the adoption of double-helical teeth, a great increase has been made in the speed at which heavy gearing is run, and in many cases there are now successfully adopted speeds which in former days would have been regarded as utterly impracticable. The most striking instances of this (says *Engineering*) which we have come across is in the case of a pair of double-helical wheels at the works of Messrs. R. Johnson and Nephew, the well-known wire-drawers of Manchester. These wheels, which were cast by Messrs. Sharples and Co., of Ramsbottom, Lancashire, are 12in. wide on the face by 6ft. 3in. in diameter, and they have now been running for over a year at 220 revolutions per minute, the pitch-line speed being thus 4,319ft. per minute. Notwithstanding this enormous speed, the wheels run with scarcely any noise, and their working has been most satisfactory. This is the highest speed we have heard of for geared wheels running iron to iron, and the fact that it has been adopted with success is a most interesting one.

CORRESPONDENCE.

We do not hold ourselves responsible for the opinions of our Correspondents.

POLLITT AND WIGZELL'S ENGINES.

To the Editor of "The Practical Engineer."

Sir,—I am very sorry that you have been restrained from publishing diagrams, as per promise, as from my own personal observations amidst many of the largest and best engines by the above firm, I can say that in all cases they either have the cut-off valves screwed right in, and throttle-valve wide open, and even in many of them cut-off valves out altogether, and after all, 15lb. to 20lb. less pressure in the cylinders than that carried by the boilers; and I firmly believe the diagram you have in hand would have shown the engine was taking very little steam owing to the lightness of load. It is a well-known fact that steam cannot follow the piston through the small clumsy thoroughfares with even a moderate load, let alone the maximum economical load per cylinder capacity and piston speeds. If so, why should a firm in the same town as "J. W. J." writes from call in another firm of engine-makers to take away the small cylinder of the last new engine of Pollitt and Wigzell's make, and by substituting another one save from 10 to 12 tons of slack per week. We engineers, daily toiling to get the best possible fuel consumption, like to see good diagrams; but light-load pictures do not prove that Pollitt and Wigzell's engines are anything different to what "J. W. J." has often heard. On the other hand, many are the engineers and millowners who have found themselves so fixed, to their sorrow, and who happen to have plenty of work for their engines to do, the same being performed daily, to their utter disgust, are actually ashamed of producing their diagrams when asked for. I may say I know of a firm in Leeds, Yorkshire, with Pollitt and Wigzell's engines that used to work anything but economically; but the valves have been reset, and lap put on to main valves, and cut-off plates made use of, and the engines are now running much smoother and using less fuel to drive the same load. The masters were surprised with the little alteration necessary. The alteration was done by an engineer not far from the same town. In conclusion, let me say it looks very strange that "J. W. J." should make such a bold start, and then withdraw without giving us a little practical information how to mend the performance of so many of our Pollitt and Wigzell's engines.—Yours, &c.,

Bradford, Feb. 27th. R. B.

P.S. I quite agree with you in saying "you fail to see how the fact of low pressure piston-rod passing through the high pressure port can have any influence on the pressure obtained in the cylinder, providing the ports are of ample size," but I may say that they are not large enough with the rod going through at the high piston speeds they run at, or otherwise more travel should be given to the valves, as the area is given in the wrong direction in steam ports.

To the Editor of "The Practical Engineer."

Sir,—In reference to "J. H.'s" letter, I should like to know how many of P. and W.'s engines he has seen diagrams from in Bradford. He says there are a great many of these engines in that town, but I doubt if he has seen any but the one that his friend attends to (who can scarcely be accepted as an authority, seeing that he came from a brick-yard engine to his present situation); so I fail to see how "J. H." or his friend can class them all alike, as there are some of P. and W.'s engines doing a great deal better than 3lb. of coal per h.p. per hour. Then he says they will never break down, simply because they can get *nothing* on; and follows this up by saying that other makers are as bad. Then why does he pitch into P. and W.'s engines so particularly. I would advise him to look round for a few of Marsden's engines, which give as bad results as those of P. and W.; and I think it shows palpable ignorance on his and his friend's part to think that the readers of *The Practical Engineer* should doubt the honesty of the diagrams sent in to you. Perhaps the reason is that he is used to tampering with them after they are taken. Then I think, Mr. Editor, you might have given more particulars about the diagrams. Please say what the terminal pressure in high-pressure cylinder, also initial pressure in low-pressure cylinder, and how far it is maintained without falling, unless you could find space to reproduce in your valuable paper.—I am, yours, &c.,

Bradford, March 6th, 1888. Study.

[The final steam pressure in the h.p. cylinder just before exhausting is 11lb. at the front and 12lb. at the back end. The initial pressure in l.p. cylinder is 2lb. at the front and 3lb. at the back, but falls immediately with that in the small cylinder.—Ed. *P. E.*]

IRISH INDUSTRIAL PROBLEMS.

To the Editor of "The Practical Engineer."

Sir,—That you are right in describing the above as one of the greatest economic problems of the day, I venture to say none will attempt to deny. Many of the conclusions you draw in your valuable article may also be accepted, while one or two others might have been drawn in addition thereto. Take, for instance, the high-handedness and heavy tolls enforced by our English railways on all whom they find are within their grasp, while every concession, involving almost an absolute loss to the companies, is conferred on the foreigner. We, as a general public, are also in a great measure to blame for the importation of much foodstuff by merely pandering to our fancies, not that we get them either cheaper or better, but because they are pushed by the vendors. Take, for instance, the butter, bacon, and egg trades, in which the Irish brands (in spite of competition and unfair railway tariffs) stand pre-eminent, and it is difficult to see how eggs would be gathered in France and sent, say to Liverpool and Manchester, to compete with Irish, if there were any reasonable comparison in the cost of transit. The same might be said as regards Dutch and Irish butter, and Irish and American bacon, and I think the Government might go even a little further, and not only materially assist railway undertakings in Ireland, but also bring some influence to bear on the railway companies, in enforcing a free-trade tariff on all kinds of provisions and foodstuffs, and not allow them to carry foreign stuff 1,000 miles for less than an Englishman's or Irishman's would cost in being carried 100, and in many cases 50 miles. Anyone who has visited Ireland must certainly have noticed the want of convenient transit, the railway service being simply frightful, but it is such as circumstances will warrant. There is no doubt that there are many quarries and mines in the North and West of Ireland, as well as many convenient well-sheltered harbours, suitable for fishing fleets, but he who opens up a quarry or a mine cannot open up a railway at the same time, and what cannot be done by the capital available in the locality should be assisted from the national exchequer, and I believe that there are many parts of Ireland (in the south and west particularly) that would become busy hives, if there were a suitable outlet for what they can produce ; nay, in many cases "a fair field and no favour" would greatly assist them. If a railway were constructed, to allow a full development of the local industries, many other industries would eventually spring up. The abundant supply of good pure water would be a great inducement to many, were it not at present a matter of transit. It is pleasing, and must be gratifying to the Irish people, to see a meeting such as you report as being held at the Grand Hotel. There appears, however, one feature in the meeting which will raise doubt in the minds of many as to the success of the quarries in question.

There are doubtless many who know the character of the people of the Mullet district quite as well as Mr. Davitt. One gentleman at the meeting, I know, has a thorough knowledge of Ireland. While from Mr. Davitt's remarks and promises it may be inferred that the *absence* of the National League means peace and happiness, and the co-operation of himself and the people of the district can be guaranteed *at present*, in conclusion I would ask how long will the people remain peaceful, and how long can Mr. Davitt's assistance and co-operation be guaranteed?

Trusting you may find room for this, I am, yours truly,

March 5th. DENNIS MALONE.

BOILER REGISTRY AND INSPECTION BILL.

To the Editor of "The Practical Engineer."

SIR,—I see from your last week's issue, "Public Interest" would have men dismissed, should the Board of Trade not grant them a certificate, even after a service of twenty years. I suppose he would have those men turned into the ranks of the unemployed, and their wives seeking relief from the workhouse, which is already too full ; or would he take such interest in these men as to find them employment of a kind that they could do? Sir, I look at such a letter as a gross insult to those "ignorant men," as "Public Interest" calls them, who have managed an engine and boiler for twenty years or more with the utmost skill and attention, and without a single accident. Perhaps "Public Interest" is one of that class who have nothing to do but find fault with those who do the work.—I am, yours, &c.,

March 5th, 1888. WORKING ENGINEER.

To the Editor of "The Practical Engineer."

SIR,—Having read several letters in your valuable paper touching on the Boiler Registry and Inspection Bill, I also, with your kind permission, would be glad of a little space for a few remarks. I cannot see how boiler insurance companies can prevent explosions to any great extent. In the first place, we are all aware that it is not the thin, corroded, worn-out old kettles on the point of exploding that are chosen by the companies for insurance, but those that will bear the minutest examination by the inspector as to principle, age, position, and condition, &c., so that my idea of the present method of insuring a boiler is that it insures the owners pocket instead of the lives of the public. Now, anything connected with a vessel making it unseaworthy, be it insured or not, is not allowed to be sent to sea until all is made right ; while some land boilers are allowed to work, year after year, in an unfit state, and the owner perhaps at the same time is enlarging and extending his plant, and therefore requiring a higher pressure owing to the load on the engine becoming heavier. We then turn to look at the attendant's remedy. If he is not what he ought to be, a practical man, he simply puts more weight on the safety valve, but keeps it a secret to see how it acts; but the next morning the papers tell of an explosion, giving lists of the killed and wounded (the stoker often among the first named), so there is no one left to account for the cause, as he has taken his secret with him. Who should be blamed, the poor unfortunate man, or the owner of the boiler for employing a man whom he neither knows nor cares if he is efficient in the management of boilers so long as he works for a low wage? Well, I ask the readers of your paper what sane man can come to the front and say that engine and boiler attendants have not as much right to a Board of Trade certificate on land as well as on sea.—I remain, yours, CRANKPIN.

March 6th, 1888.

HIGH-SPEED REVOLVING STEAM ENGINE.

To the Editor of "The Practical Engineer."

SIR,—In *The Practical Engineer* of February 24th a revolving engine is described as patented in 1887 by Mr. Arthur Rigg, Engineer, Old Broad Street, London. The principle of this engine has been anticipated by Mr. Schwarz, of Southampton (but the details vary), who published a description of an engine and pump invented by him in the *English Mechanic and World of Science*, No. 1,102, May 7th, 1886.—Yours faithfully HAROLD H. LINDON.

Little Sutton, near Chester, March 5th, 1888.

UNCERTIFICATED ENGINEMEN AND THE RESULTS.

To the Editor of "The Practical Engineer."

SIR,—I wish to address, through you, those friends and enginemen who have taken a great interest of late in the question of granting certificates to enginemen. I am sure that you all ought to know that this is the time of improving your situations and pay, and I hold a very strong opinion that, no matter how good and well tested a steam boiler or a steam engine may be, accidents to boilers and machinery will take place so long as the men in charge are not put to any qualifying test themselves. Owners usually, and very properly, insist upon their boilers being made of the best material, and on the latest pattern, and they do not object to paying a good price for a good boiler ; but, alas, the matter begins and ends here in a great many instances, and it is not an uncommon thing to find men in charge of fine machinery who cannot explain a tenth of their proper duty towards it. We cannot complain of this, because when a man is out of work he is ready and willing to take charge of such engine, boilers, &c., even if he has never had anything to do with them at all in his life, providing he can persuade the owner to take his word as to his experience. A good engineman's eye is trained, and it detects the very least appearance of evil, and he, being full of opinions, wants to be nipping the evil in the bud. The unskilled engineman is in many cases the simple honest man who will work the machinery months without even examining it, let alone doing any repairs, until a shaft breaks, or a rivet leaks week after week, and corrosion has eaten the iron completely away and a hole appears. Then he begins to feel his position, and say to himself, "I can't make this out, I wish I were in heaven," and such-like, being afraid to tell the owner, fearing he may get discharged ; or he will overload safety valves by laying bars of iron over the levers—I have known fire-bars to be placed upon them—so that he can make one boiler do the work of two, thinking that the owner will take a liking to him, till at last away fly the boiler plates, and perhaps himself, too, up in the air ; and then what does the owner think of his uncertified man? But, as I have stated, no one can blame a man for making his way into the engine-room. The law does does not interfere with the matter only by sending some one or two gentlemen to look at what he has done. The loss has to be borne by the owner ; or perhaps he would, seeing that he had a cheap man, have his boilers insured, in which case the insurance company would bear the loss. Some time ago an effort was made to establish the system that ought to have been in existence long ago, viz., of granting certificates of proficiency to enginemen. By such means I think a great many lives might have been saved that have been sacrificed ; and I do hope that enginemen will now keep the matter up all over the country, and have their status brought to a higher standard than it has ever reached before. From the limited number of men (I am sorry to say this) who feel disposed to assist in this work it seems as though the men themselves do not care for certificates, whilst the masters do not want them to care. I myself cannot see why the enginemen of land boilers and engines cannot have the same protection as marine enginemen, and have an association.—I remain, yours, &c., ENGINEMAN.

Leicester, March 5th.

TEST FOR CEMENT.—A standard test in Prussia for determining whether the volume of a cement remains constant on hardening is: Cement is mixed with water to the consistency of a thick cream, and formed into a thin cake on either a glass or metal plate, or a roofing tile saturated with water. After setting, the cake and plate are placed under water and there allowed to harden, when any change in the volume of the cement is indicated in the course of a day or so by the crumpling of the cake or cracking occurring at its edges. A more severe test consists in allowing a cake of the cement, formed as above, on a glass plate, to harden for a period of twenty-three hours in air, and then placing it in boiling water, when any tendency of the cake to crack at the edges or crumple is shown in from ten to sixty minutes.

QUERIES AND REPLIES.

Emery Wheels.—Will someone inform me of a good solution for securing emery to an emery wheel?—Constant User.

Answer.—A good authority has given me the following reply to "Constant User's" question:—Take a wooden wheel with an iron centre, and covered with leather, and coat the leather over well with ordinary glue. When the wheel is well glued, run it in a trough of granulated emery; and when the emery ceases to adhere to the wheel, lift it out of its temporary bearings and leave it to dry, a process involving two or three days' delay. The best way is to have two wheels, so that one may be in use while the other is being repaired.—Old Finsburian.

Speed of Vessels.—Can any reader give me a formula for obtaining approximately the speed of a steam vessel with a given H.P., without going into any very intricate calculations.—F. W. B.

Answer.—An approximate formula for the speed of a given ship with a given horse-power is as follows:—

$$V = \sqrt[3]{\frac{HP \times K}{A}} \quad \text{where}$$

V = velocity of ship in knots per hour.
HP = indicated horse-power.
A = area of of immersed midship section in square feet.
K = a co-efficient, called the sectional co-efficient of performance, which varies for each different form of ship, but is approximately taken as 600.

If the querist does not know the area of immersed midship section A, he may take it to be about ·9 times the draught in feet multiplied by the beam (in feet). If he prefers to use the *displacement* as a factor in his calculation, the following formula will suit:—

$$V = \sqrt[3]{\frac{HP \times x}{D^{\frac{2}{3}}}} \quad \text{where}$$

V and HP have values as above, and
$D^{\frac{2}{3}}$ is the cube root of the square of the displacement in tons, and
x = a co-efficient, called the displacement co-efficient of performance, and which may be taken with very fair results as $x = 240$.

If "F. W. B." has not got the displacement, he might calculate it approximately by the formula—

$$D = \frac{L \times B \times D_1 \times \cdot 6}{35}$$

where D = displacement of ship in tons.
D_1 = mean draught of water in feet, deducting the depth of keel.
L = length between perpendicular in feet.
B = extreme breadth in feet.
·6 = a co-efficient of fineness, which may be varied to ·7 for cargo steamers.

By working out both equations for V (the speed), and then taking a mean of the two, a very fair result is obtained.—Omicron.

Faucet Joint.—What is the best means of making a steam faucet joint tight at 40lb. pressure?—W. S.

Answer.—If the joint is to be permanent, I think a rust-joint would be best, for if well put in it will become almost solid with the pipe. The following proportions from Molesworth's Pocket-book will answer the purpose:—

Quickly-setting: 1 sal-ammoniac, in powder (by weight); 2 flour of sulphur; 80 iron borings made to a paste with water.

Slowly-setting: 2 sal-ammoniac; 1 flour of sulphur; 200 iron-borings.

The latter cement is best if the joint is not required for immediate use. The cast-iron borings should be passed through a sieve of about nine meshes to the inch. If the joint is not permanent, it might be packed with a few coils of soft rope well red-leaded, and screwed tight by means of a gland, the bolts being put through a loose collar on the socket end of the pipe.—Ports.

Cleaning Skylights.—Which is the best way to clean skylights in an engineering works, where soot and dirt stick fast on the glass? What is the best thing to use with water so as to fetch the dirt, &c., off quickly and cheaply?—J. A.

Answer.—The best I have found for removing soot, &c., from glass is a wet cloth steeped in water and dipped in flint dust. Scour well, then polish with a little of the dust on a dry rag or wash-leather. You will also find that in nearly all the large collieries in Derbyshire it is used to clean the bright parts of engines as follows: mix flint dust to a paste with one of the following three—spirits of turpentine, paraffin, or mineral oil; scour the parts and let it dry on; then get a piece of cloth or flannel, thoroughly dry, add a little fresh dust to that which sticks on, and polish. It is cheaper than Bath brick.—D. E.

Brickmaking Machinery.—Whose brickmaking machinery is most suitable for working up colliery spoil banks? A general description of the arrangement and some idea of the cost of a 20,000 per day plant would be very acceptable.—G.

Steel Plates.—Will some reader kindly give me a list of lengths and widths of iron and steel plates kept in stock by most merchants. What I want is to be able to design tanks, boilers, &c., without having to get them cut, as this increases the labour, and does not add anything to the strength.—H.L.C.

Automatically Closing a Steam Valve.—Can any of your readers inform me of a method for automatically shutting, in a given short time, a steam valve that is opened by a movement which is too quick to be utilised for closing it, and where there is no other motive power available? I have heard that a wing valve would be suitable, but have no knowledge of such a valve, and should be obliged for a description of it, or any other method that would answer my purpose.—Piston.

Could any reader inform me how I am to make the following: I want some aluminium tubes about 1½in. diameter, $\frac{1}{16}$in. thick, and about 1½in. long, with flanges on the end. Can I buy the tubes ready made and solder the flanges on, or should I have to get sheet metal, and bend it over, and solder it up all along to make them? What would be the best kind of solder? Is aluminium very expensive, and who manufactures it?—W. Ll. P. W.

Marine Problems—Propeller Slip.—A certain propeller is removed and replaced by another of the same pitch, but with greater "slip." What effect will this have on the speed of the vessel, the engines working at their highest power in each case? The revolutions would apparently increase, owing to the load being lightened, but how would this affect the speed of the ship?—Q.

Illuminating Paint.—I should be glad to have the address of a maker of illuminating paint.—S. C.

Steel Castings.—Would any of your readers give me any information as to the theory of moulding and casting the above? Also if there is any work published on the subject?—Moulder.

Copper Cylinders.—Could any reader kindly give me a simple, but reliable, formula for the collapsing pressures of copper cylinders subjected to external pressures? The dimensions of the cylinders vary from 12in. to 36in. in length, and from 12in. to 36in. in diameter. They are made of sheet copper with a single-riveted lap joint, brazed. They are flanged at the ends, the flanges being put on to receive bolt holes, not to strengthen them. The external pressure is the pressure of the atmosphere, there being a vacuum inside the cylinders.—Old Finsburian.

Priming.—What are the chief causes of priming in marine boilers, and the remedy for same. I should like to be favoured with the construction of the hydrometer or salt guage.—Anti-Primer.

Ramsbottom Piston Rings.—Will some reader give me a little information on expanding Ramsbottom piston rings, steel and cast iron, for cylinders 12in., 16in., and 20in. diameter, varying from $\frac{3}{8}$in. to $\frac{5}{8}$in. wide, and $\frac{1}{4}$in. to $\frac{3}{8}$in. thick.—A. J.

TO CORRESPONDENTS.

J. Haming.—The "Star" hack saw, described in our issue of the 10th February, was purchased from Mr. J. J. Harley, 27, Old Haymarket, Liverpool who, we believe, imports American tools.

To Intending Marine Engineers.—We are constantly receiving from readers, who are anxious to become marine engineers, inquiries as to how they should proceed in order to obtain a situation as engineer at sea. The following is a full reply to these inquiries, and we trust it will prove sufficient: The applicant must have served his time with an engineer, and be a mechanic. It is not necessary to know anything about marine engines, though such knowledge might tell in his favour where there are many applicants. He must apply *personally*, and be ready to show certificates from his various situations. Application by letter only is perfectly useless. If the applicant does not know of any line in particular which he would prefer, let him look up a directory and get the names of as many lines of steamers as he can in the nearest seaport; then go to the office of the superintending engineer, and state his case. If his name is taken down in the books, he should call once or twice a week to see if anything has turned up, unless forbidden to do so. Whoever happens to be on the spot usually gets the situation, regardless of priority in the books. An introduction, however slight, will sometimes give the applicant a better chance than he would otherwise have. The pay to start with will vary from £6 to £8 a month. African lines pay best, on account of the risk of fever, &c., Mediterranean and Baltic lines the least. The pay of chief engineers varies from £14 to £18 a month, though sometimes more. In the larger lines it may take a man half a lifetime to attain to this, but in lines of smaller steamers, where only three engineers are carried, promotion is much more rapid, though 2½ or 3 years must elapse at the very least before the highest post can be hoped for. Once on board, everything depends on the engineer himself, unless he has ill luck, such as not being at home when a vacancy occurs to promote him to, &c.

Inquisitive.—On the contrary, the float will rise when pressure is admitted into the air chamber, because then there is a greater weight of air displaced, and there must be proportionately a smaller amount of water to effect a balance, therefore the float must rise.

T. Orr.—A. Shirlaw & Co., Suffolk Street, Birmingham.

Yorkshire.—Your diagram arrived too late to be reproduced in this week's issue. Several days' interval should always be allowed when illustrations have to be made. We will try and answer your queries next week.

Electric.—"Electricity," by W. Larden, Longmans, Green, and Co., price about 8s., contains information on all the points named in your letter, but the portion dealing with batteries is perhaps not quite as practical as you desire. This part of the subject is dealt with very fully in Urquhart's "Electric Light," Crosby, Lockwood, and Co., price 7s. 6d.

Ports.—The mean and low pressure cylinders have, practically, a large reservoir to draw from before taking steam from the cylinders in front of them, and hence the exhaust port of one may be smaller than the steam port of the next without any detriment to the steam line. It might be advisable, however, to make the exhaust openings of the first and second cylinders a little larger than given in your calculation. We should not recommend reducing the steam ports of the second and third cylinders.

J. T.—The valves are set about right, though a little earlier cut off would no doubt improve the economy a little. The engine is, however, very lightly loaded, and hence is handicapped as regards showing good results. You ought to get a better vacuum. See that the hotwell is not above 100°, and also examine all the joints and glands to discover if there be any leakage. With a light load like this the vacuum should certainly not be less than 12lbs. Read our articles on vacuum in recent issues.

H. M.—Isaac Storey and Sons, near the Cathedral.

M. M. J.—The only speed we notice in the table is given in feet per minute, which is quite right.

MISCELLANEA.

An American Ship Canal.—A bill has been introduced in the House of Representatives for the appointment of a board to direct the construction of a ship canal around Niagara Falls for the passage of merchant and war vessels from Lake Ontario to Lake Erie.

The Manchester Geological Society.—The monthly meeting of this society was held at 36, George Street, Manchester, on Tuesday last. Mr. Clifford added some further notes to his paper on the Coalfields of Virginia, United States, and Mr. Charles Hardwick, F.G.S., read a short note by Mr. R. Pollitt on the Granite of Termon, County Mayo, Ireland, and exhibited specimens and a crayon drawing, which Mr. Pollitt desired should be sent to the museum at Owens College. Mr. C. M. Percy, of Wigan, read a long paper on Mining Royalties, which took somewhat of the form of a political lecture, but some valuable statistics were contained in it.

Large Gas-Engine.—At Deutz, near Cologne, an Otto gas-engine is being made of 100 horse power effective. It has four cylinders, and will be driven by Dowson gas. It will be interesting to learn whether a gas-engine of such a size can successfully compete with modern steam-engines.

North-East Coast Institute of Engineers and Shipbuilders.—The next meeting of this society will be held on Wednesday, the 14th inst., when the discussion on Mr. J. T. Milton's paper on Slide Valve Gears will be taken, and a paper on Stockless Anchors and Fittings, by Mr. G. W. Sivewright, will be read.

Large Belt.—The largest leather machine belt in use is said to be one in New York—72in. wide, 100ft. long, and weighing 2,000lb. A rubber belt, almost as big, also hails from the same neighbourhood—it is 52in. wide, 298ft. long, and weighed 4,000lb. This belt was 8-ply thick, the leather one being 4.

Opening of New Line.—A new direct line to Bournemouth was inaugurated by the official opening on Monday. The saving in distance is 8¾ miles, but that of time from London to Bournemouth is thirty to forty minutes. The new line is 10½ miles long, and has three stations. The earthworks have been very heavy.

Niagara in London.—The wonderful Niagara waterfalls have been represented on a canvas 400 feet long and 50 feet high, by M. Paul Philippoteaux, and the picture is about to be shown in London. The representation is said to be very realistic, and therefore should be well worth the shilling that will be charged to see it.

The British Association.—The balance-sheet of the Manchester meeting of the British Association, held last autumn, has just been presented, from which it appears that the total receipts were £4,369 10s., leaving a balance of just over £100, which it is proposed to divide between the Owens College Library and the Literary and Philosophical Society.

The Dorking Tunnel.—The Betchworth Tunnel, more commonly called the Dorking Tunnel, has at length been re-opened for traffic, after being closed since last July, when the roofing fell in. An inspection has been made of the restored work by the directors and principal officials of the London and Brighton Railway. Through traffic to Portsmouth via Dorking and Horsham was resumed on Thursday week.

Work in the Government Yards.—One hundred and fifty additional mechanics have been engaged at Portsmouth Dockyard, in consequence of the proposed laying down of the Beagle, Barossa, and Barham sloops, of the Buzzard type, for which material is ordered to be prepared, and of the torpedo depôt ship Vulcan. The annual refits of the ships of the Channel, Reserve, and Flying Squadrons, and their equipments for the naval manœuvres, promised by Lord George Hamilton, will also throw additional work upon the yard. The manœuvres will be upon a much reduced scale, and will largely partake of torpedo operations.

A Fifteen Hundred Miles Tow.—A remarkable tow of about 1,500 miles has been completed. The William Jolliffe brought the Laplace from Madeira, where she had put in with a broken shaft. The tug, after coaling at Cardiff, left there on the 12th ult., reaching Madeira in about five days. The William Jolliffe left Madeira last Sunday fortnight, and has, consequently, taken only about twelve days to perform the whole distance with her charge. The Laplace is a steamer of over 1,400 tons register, and could in no way help the tug, as her propeller could not be moved, and, consequently, "dragged" in the water. Very heavy north-easterly winds prevailed.

Climate in Siberia.—The coldest spot yet found on the face of the earth, according to Russian climatic observations, is Werchojausk, Siberia. The Russian weather observing system is the most extensive on the globe, and embraces remarkable climatic contrasts. It has two principal observatories, and 255 subordinate stations, and its latest report gives rainfall observations for 650 localities. Many of the stations have lately been added, and one of these is Werchojansk. The mean temperature at that spot for the year 1885 was 2·9 deg. below zero (29·1 deg. Fahr.). For January and December it was 62·9 deg. below, and for July it rose to 60·6 above zero. The lowest temperature in July was 39·2 deg. above zero, while in January a fall to 88·6 deg. below zero was experienced. Werchojansk is in latitude 67 deg. 34′ N., longitude 133 deg. 51′ E.

Automatic Sprinkler.—A trial of the "Vulcan" Sealed Automatic Sprinkler was made on Monday week, at the Eagle Works of Mr. Samuel Walker, at Radcliffe. A bundle of straw soaked with paraffin and lit was played upon in eight seconds, and extinguished in about 42 more. A slow fire made by lighting straw only was played upon in one minute and a quarter, and extinguished after an interval of 45 seconds; while the severe test of a fire of small wood and shavings, lit just within range of the sprinkler, and at some distance from it, resulted in the water being turned on in three and three-quarter minutes. An apparatus may be attached to a system of sprinklers so that if one of them is brought into play a continuous gong and steam whistle are set going. A hydraulic test of the sprinklers, in which 1,900lb. pressure was applied, failed to dislodge the plug, thus proving the great strength at ordinary temperatures of the solder, which melts at 150° F.

SELECTED PATENTS.

APPLICATIONS FOR LETTERS PATENT.

February 24.

2739 Gas Burners, John Frederic Wright and George Ernest Wright, Birmingham.—[Complete Specification.]
2741 Calculating Machines, James Davies Burton, Reading.
2742 Lifting Heavy Bodies, Richard Gay, Edwin Atkinson Whitehead, David Thomas Young, and Harry William Young, Birmingham.
2746 Boilers, Zaccheus Sugden and Enoch Binns, Halifax.
2748 Nails, Ernest Smith Baldwin, Loughborough. (Henry Davenport, New Zealand)—[Complete Specification.]
2754 Paraffin Lamps, Edward Green Leeman, Liverpool.
2759 Gas Lamps, Charles Maynard Walker, Dulwich.
2761 Softening Water, Robert Edward Phillips, London. (Francis Strudwick Harwood, Portugal.)
2762 Purifying Sewage, Robert Edward Phillips, London, (Francis Strudwick Harwood, Portugal.)
2764 Circular Bits, James Sharples, Halifax.
2767 Exhaust Pumps, Strethill Harry Wright, Liverpool.
2771 Lock Nuts, Francis Sanders Morris, London.
2773 Lock Nuts, William Tozer and Charles Frederick Archer, London.
2775 Instantaneous Water-heaters, William John Righton, London.
2779 Heating Water, William John Payne, London.
2780 Type-writing Machines, Ferdinand Dick Butler, London.
2783 Hydraulic Presses, Ralph Hart Tweddell, James Platt, and John Fielding, London.
2784 Electrically Lighting Railway Carriages, John Imray, London, (Robert Imray, South Australia.)
2788 Mitreing Machines, Thomas Austin Sergeant and William Edwin Cook, London.
2790 Writing Pen, Gibbard Richard Hughes, London.
2793 Lock Nut, Joseph Emile Lansard, London.
2803 Manufacture of Artificial Stone, John Brunton and Lewis Griffiths, London
2804 Gas Engines, James Yate Johnson, Middlesex. (La Société Salomon fréres et Tenting, France.)—[Complete Specification.]
2805 Starting Gear for Gas Engines, James Yate Johnson, Middlesex. (Edouard Delamare-Deboutteville and Léon Paul Charles Malandin, Prance.)—[Complete Specification.]

February 25.

2807 Gas Lichting, William Brown, London.
2810 Destructive Distillation of Shale, Robert Brown Tennent, Glasgow.
2811 Pipe Joints, Henry Rallings, Birmingham.
2812 Screws and Boring Tools, Israel Drakeford, Birmingham.
2815 Fireproof Floors, Mark Fawcett, London.
2826 Boring Tools, Hermann Arnz, Manchester.
2832 Uniting the Ends of Cast-iron Pipes, Edwin Husselbee, Birmingham.
2834 Portable Drilling Machines, Frank Jackson and Edward Robert Austin, London.
2841 Lubricating Locomotives, William Stroudley, London.
2842 Tools for Polishing Stone, James Yate Johnson, Middlesex. (Emile Fabre and Auguste Tronche, France.)
2849 Valve Gear, Alexander Hunter, London.
2850 Steam Engines, James Carlton Stitt, Liverpool.

February 27.

2884 Hydraulic Accumulator, Robert Haswell, Hartlepool.
2891 Oil Lamps, Jerome Carroll, London.
2895 Forcing Waste Steam Back to Boiler, Robert Curson and Frederick Curson, West Hartlepool.
2896 Steel Making Furnaces, James Riley, Glasgow.—[Complete Specification.]
2899 Regenerative Furnaces for Steel Making, James Riley, Glasgow.—[Complete Specification.]
2903 Manufacture of Steel, Percival Moses Parsons, Blackheath.
2913 Gas-Engines, Wilhelm von Occhelhaeuser, London.
2916 Forcing Metals, Howard Lane and Samuel Graham Browne, London.
2927 Wrenches or Spanners, Henry Bornstein, London.—[Complete Specification.]
2928 Rock Drilling Apparatus, Thomas Hugh Bell, Addison Langhorn Steavenson, and Robert Clough, London.
2934 Pipe Connections for Pneumatic Brakes, Ludwig Blatt, London.
2936 Screw-Propellers, John Harper, Liverpool.

February 28.

2940 Hydraulic Presses, George James, Birmingham. (Arthur Edwin Hobson, United States.)—[Complete Specification.]
2944 Smoke Burning Apparatus, John Cope Inskeep, Bolton.
2945 Back Pressure Valves, Nicholas John Ginman, Halifax.
2956 Electrical Fog-Signal, Arthur Butler Harris, Oxford.
2963 Apparatus for Sighting the Interiors of Steam-Boilers, John Clark and Thomas Struthers Mc.Innes, Glasgow.
2986 Governor Engine, Joseph Higginson, Junior, London.
2991 Incandescence Gas-Burners, Carl von Buch, London.
3007 Machines for Bevelling Glass, Paul Augustine Marie Dominique Olivier de Fleury, London.—[Complete Specification.]
3014 Centrifugal Machines, Otto Braun, London.

February 29.

3052 Joint for Steam Pipes, Neil Gilmour Haran, Glasgow.
3055 Vices, Joseph Samuel Laycock Ashforth, Sheffield.
3062 Portable Engine Chimneys, William Arnold, Skelmersdale.
3069 Rotary Engines, John Stebbing, Potterspury.
3071 Miners' Safety Lamp, John Pearson, London.
3099 Rotary Compound Engines, James Plaister Harris Gastrell, London.
3101 Pile Driving, Eugene Turpin, London.—Received 29 February, 1888.—Antedated 17 February, A.D. 1888.—Under International Convention.

March 1.

3129 Steam Generator, Wilhelm Hök, Sunderland.
3133 Cable Tramways, Robert Cooke Sayer, Bristol.
3144 Brick-making Machine, Henry Watkinson and Herbert Partington, London.
3145 Oil Cans, Thomas Fletcher Braime, London.
3158 Manufacture of Metallic Screws, John Sheldon, Middlesex.
3168 Lubricators, John Dewrance, London.
3170 Ball Valves, Frederick John Henderson, London,

NOTICE TO NEWSAGENTS AND SUBSCRIBERS.

Numerous complaints having been made to us by Subscribers of the difficulty they experience in obtaining copies of the *Practical Engineer* in certain districts, we have to state that the Journal can be obtained by any Newsagent through the ordinary trade channels, and no difficulty should therefore exist in obtaining copies by order of any Newsagent.

For the information of the trade, we may state that copies can be obtained from either of our Offices in London or Manchester, or from any of the following wholesale houses, who are also supplied with Contents Bills for the use of the trade:—

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&c., &c., &c.

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EDITORIAL NOTICES.

All communications for the Editor of this Journal should be addressed to 6, Victoria Station Approach, Manchester.

Communications intended for insertion in the current week's issue should reach us not later than Tuesday Evening.

We cannot undertake to return rejected manuscripts or drawings unless accompanied by a stamped and directed envelope.

Contributors are requested to write on one side only of the paper. Sketches should be sent on separate sheets.

TO ADVERTISERS.

Advertisements intended for insertion in the current issue should reach us on Wednesday morning at the latest.

Important Notice to Newsagents and Subscribers.

Our Publishing Offices in London are now at 11, PATERNOSTER BUILDINGS, E.C., where the Trade will in future be supplied.

Simultaneously with the above change, our PUBLISHING OFFICES in MANCHESTER have been REMOVED from Grosvenor Chambers, Deansgate, to more commodious and convenient premises at 6, VICTORIA STATION APPROACH, where all communications intended for the Manager or Editor should, in future, be addressed.

THE
PRACTICAL ENGINEER.
MARCH 16TH, 1888.

IRISH INDUSTRIAL ENTERPRISE.

In a recent issue we alluded to the extreme poverty that exists in the western part of Ireland, and in fulfilment of our promise now give some further description of the Mullet and the granite quarries of Black Sod Bay.

Belmullet, situate on the isthmus that joins the Mullet to the mainland, is a market town and port, and the centre of business for some distance round, its Saturday market being attended by people who live twenty miles or more away, and who walk in and out that day, often for the mere pleasure of seeing and hearing what goes on around them. The Irish Board of Works have lately expended considerable sums of money in extending the quay walls and dredging out the harbour to greater depth, so that vessels may come alongside. These works have been constructed under the superintendence of Mr. Binns, the resident engineer, and cannot fail to be of great benefit to the port, especially after the construction of the proposed railway.

There is now very little trade. A few oats and potatoes are exported, and cattle are reared for the English market, but all on a small scale. Pork, bacon, and eggs are very plentiful, and geese can generally be purchased at eighteenpence each. Wild fowl are plentiful, and rabbits are caught in the sandhills of the Mullet, and sent to Manchester, usually by parcel post. The few strangers who visit the district are English sportsmen, who find snipe, and curlew, and wild fowl shooting in perfection.

As you leave Belmullet to go by road to Fallmore, at the southern extremity of the peninsula, you are struck with the number of roofless cottages and fields once cultivated, but now falling back into their original condition of peat bog. Bingham's Town is found to consist of perhaps forty cottages and a roofless market-house, and of the cottages not more than five or six are tenanted. A little further may be seen a grass-grown quay, once intended for the use of Bingham's Town; a few miles to the south also Bingham's Castle, the seat of the once opulent Binghams, but now almost a ruin, and the family now do not receive a shilling from their ancestors' lands. This district is rented by Mr. Reilly, the great cattle dealer, whose rental, although considerably reduced, is now £1,800 a year.

On inquiring the reason of the vacant cottages and the uncultivated clearings, one is told that the people have emigrated, the fact being that they were starved off, and anyone acquainted with the rudiments of farming would see at a glance that it is an impossibility for anyone to make a living in the way the peasants tried it, or in fact in any other way. The land is worthless for farming purposes, and sour from long-continued dampness. There is, of course, little or no manure to be had, but seaweed is used to a limited extent. If it were possible for the land to do any good, the artificial manures made from the sewage of our large towns would be just the thing to make it do so, and perhaps some business may be done in this way when the Ship Canal enables the manure to be carried cheaply to the district.

The extension and vigorous working of the Termon Granite Quarries would altogether change the appearance of things. The provision of work for an otherwise idle peasantry would introduce money, and cause a general trade to spring up in the district, and perhaps cause an extension of the fisheries, as well as other industries.

The granite occurs as a sort of "boss," surrounded on three sides by metamorphic rocks, and on the other side by the waters of Black Sod Bay; it is similar to several isolated "bosses" or "hummocky" masses which are found in other parts of the west of Ireland. Its total extent is about three miles from north to south, and one mile from east to west. It appears to have been protruded through the metamorphic rocks, and at this time probably obtained its wonderful and unique bedding as a result of the tremendous pressure.

The best portion of the granite extends for about a mile southward along the shore from the Termon Pier, which was built of the rock more than thirty years ago by the Irish Fishery Board, and bears excellent testimony to the durability of the granite. The Coastguards' Station and the Lighthouse are situate at the same point, and are also built of this granite.

Those of our readers who visited the Irish Section of the Manchester Jubilee Exhibition would be struck with the pleasing nature of the exhibit of the Mayo Granite Co., which was produced at this quarry. The fine polish and pleasing variety of colour and evenness of texture of the stone at once show it to be extremely well suited for architectural and monumental work.

In the quarry it shows a peculiar bedding, which, together with the vertical jointing, enables it to be obtained in roughly square blocks and slabs varying in thickness from 3in. or 4in. to upwards of 3ft., and up to 8ft. in width and 40ft. in length. This peculiarity is a striking feature, and enables this granite to be worked with almost the facility of freestone, and a minimum of blasting is required; a great contrast to the granite of other quarries, which requires the use of enormous quantities of explosives, and results in the blowing off of shapeless masses that require cutting into blocks by expensive hand labour.

Up to a year ago it was only worked for local purposes, such as the Termon and other piers and lighthouses, the Belmullet Quay, &c. But it has lately been put upon the English market, and is meeting with a ready sale. Preparations are now being made for the extensive development of the quarries; a tramway is laid, and three large cranes, and tools of various descriptions are already fixed and at work.

Considering the great facilities for shipping, the cheapness with which it can be worked, the low price and abundance of labour, and the excellence of the quality of the rock, the only wonder is that it has remained so long undeveloped. An American who has lately visited the quarry, states that the whole of the out-put could be sold in New York at prices to leave a very handsome profit; but we think that most of the granite will be absorbed in Liverpool, Manchester, Bristol, and London, where it can compete against any English or Scotch quarries both for quality and in price.

We hope that our anticipations of a more prosperous future for the county of Mayo may be more than realised, and we have already intimations that valuable lodes of copper have been discovered near Westport and near Ballycastle, which will shortly be opened out.

THE WORKING OF AN ENGLISH RAILWAY.

Lieut.-Col. Findlay delivered a very interesting lecture last week at the School of Military Engineering, Chatham, on the "Working of an English Railway." After describing what would be necessary to assure our safety in case of invasion, at least as far as the perfect equipment of our railway system could affect the issue, the lecturer went on to speak of the London and North-Western Railway, and said that to carry on the immense traffic of this railway the main essentials are a sound permanent way, powerful and efficient engines, an ample supply of suitable rolling stock, the most perfect signalling and telegraphic arrangements—especially the block telegraphic system—continuous brakes, and last, but not least, a highly-trained and thoroughly qualified staff. In referring to the compound engines of Mr. Webb, the lecturer rather innocently attributed their economy to the fact that after the steam had once done duty it was "compelled by an arrangement of duplicate cylinders to do duty again," a statement that might lead some of his hearers to wonder why the steam wasn't made to do duty a third or a fourth time, or, in fact, any number of times, and so save practically all the fuel instead of a small proportion. The brake gear, signals, &c., were briefly described, and then the lecturer referred to the extraordinary precautions that were taken when the Queen travelled by rail in order to avoid accident. The extraordinary complexity of the operations carried on by, and method of working of a single railway company are so great, that it is almost impossible to get an adequate idea of them, and, of course, could only be presented in the briefest outline in a single lecture.

TECHNICAL EDUCATION.

A deputation from the Executive Committee of the National Association for the Promotion of Technical Education waited last week on Viscount Cranbrook, the President of the Council, to urge the desirableness of making grants in aid of University Colleges. Lord Hartington, Sir H. Roscoe, and Sir Lyon Playfair, amongst others, spoke in favour of these grants. Ten institutions such as Owens College, Manchester, the Yorkshire College, Leeds, the Mason College, Birmingham, were named as being in the opinion of the association worthy recipients of such aid. In all these cases local effort has done a great deal, as, for instance, in building the engineering laboratories at Leeds and Manchester; but the possibilities in this direction are getting pretty well exhausted, and the association, therefore, proposes that the State should grant £4,000 to £5,000 a year to each of them, according to fitness. Part of this money would go to founding scholarships for boys from elementary and secondary schools, and the rest to giving each institution a sound financial basis to work upon. The Lord President, after listening to the speakers named above, gave an encouraging reply, and promised to bring the matter before his colleagues and the Chancellor of the Exchequer, without whose purse he could do nothing. We trust that with the surplus that is likely to be realised this year, the latter will not put any obstacles in the way, and that therefore we shall ere long enjoy some of the advantages to be derived from the suggestions made. It is not expected by anyone that the State shall do everything in this matter, but we believe it is only reasonable for it to second some of the magnificent individual liberality that has been shown, by assisting ever so little in the work of technical education.

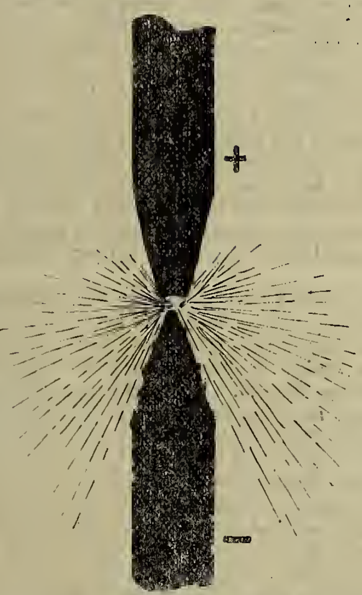
THE MÉKARSKI AIR ENGINE.

After various delays, several tramcars driven by compressed air on the Mékarski system have recently been placed on a tramway line in the north of London, where they are regularly taking their turn in working the traffic with the ordinary horse-drawn cars. The Mékarski system consists of a station where the air is compressed and stored for delivery into reservoirs placed under the cars. The air in its passage from the reservoirs to the engines, which are also under the cars, passes through hot water and steam, which are charged into a receiver on the car at the compressing station. The heat further expands the air, and also prevents the formation of snow in the cylinders due to the expansion of the compressed air. The tramway upon which the cars are running is that section of the London Street Tramways Company's lines between Holloway Road and the King's Cross Station of the Metropolitan Railway. It is about two miles in length, and has several heavy gradients and sharp curves. The Mékarski cars, which resemble the ordinary horse-drawn cars, keep time and observe all the other conditions of traffic. The introduction of the air-driven cars by the tramways company on their line has been decided on in consequence of the economy of the system over horse traction, and this notwithstanding that both horses and forage are at a comparatively low price. The inauguration of the practical introduction of the system recently took place, when a number of gentlemen interested in tramway working were present at the invitation of the British Mékarski Air Engine Company, of 110, Cannon Street, London.

ELECTRIC WELDING.

Much interest has lately been taken in the question of the adaptability of electricity to the welding or brazing of various metals, and last week we gave illustrations of Bernardo's method of electric welding, which will have been noted with interest. There are two methods by which the heat produced by the electric current may be taken advantage of: first, by the incandescence directly produced in substances having a great electrical resistance, such as carbon or platinum, by the passage of a powerful current through the same, illustrated by the ordinary incandescent or glow lamps; and secondly, by the great heat produced locally by the increased resistance afforded by the electric arc, as in the arc lamps used in electric lighting.

In using the former method to melt metals employed in the various arts, we may surround a crucible, containing the material, with a helix or coil of platinum wire, or foil, or we might, with advantage, use carbon rods of relatively small section. If a powerful current of electricity be then passed through the coil, an intense heat will be produced, sufficient to melt the most refractory material. In such a furnace iron and steel could be heated, and afterwards manipulated as required; but as it is more particularly with the second method we wish to deal in this article, we at once attempt to put the matter as clear as we can before those readers who may not have had an opportunity of witnessing the effect produced.



The heat produced in a conductor varies in direct proportion to the resistance offered by it, so that the increase in resistance afforded by the electric arc is more favourable to the production of heat than is the incandescence, which is merely due to the resistance of the material used in an uninterrupted circuit.

In considering the adaptability of the electric arc to the purpose of welding, it would be as well to know what takes place during the passage of an electrical current. On viewing the arc, formed between two carbon points by means of a ruby glass, particles of incandescent carbon may be seen traversing the space between the two poles. The transference of these particles takes place in both directions, but more especially from the positive to the negative pole, and after a short period of working the two poles will be found to have assumed different forms, the positive carbon or pole having at its end a crater or cup-like cavity, whilst the negative carbon will have assumed a more pointed form, as shown in the accompanying sketch. It is found in practice that the positive pole burns away twice as rapidly as the negative; therefore it may be safely asserted that in forming an electric arc between any metal and a carbon point, if we make the metal the positive pole and the carbon the negative, the material will be found to consume away very rapidly. This is in effect what was discovered to be the case by the first experimenters of the system. Recently, however, the matter has been resuscitated by a learned professor in Russia, but with somewhat better results, he ascribing his greater success to the fact that he makes the carbon pencil the positive pole of the arc.

The writer had occasion to witness some experiments which were being conducted quite recently, in view of the advisability of adopting the system for the purpose of burning together iron and other castings which may have become broken, and to determine the practicability of the scheme as applied to welding or brazing together thin plates of iron, brass, copper, tin, &c. The experiments were to some extent most encouraging, seeing that under the influence of the heat of the arc—which, by the way, has been stated to be above 5,000° centigrade (9,000° Fahr.)—wrought iron, cast iron, and steel were rapidly converted into the molten state. For the purpose of piercing holes in metal plates the system seems feasible, as a hole may be readily formed in a plate of reasonable thickness in a very short time. Cast-iron boxings may become welded together quite readily when operated upon; but the writer thinks that, in view of the great care which is found necessary in the manipulation of steel to prevent the injury to it caused by overheating, the heat of the electric arc is too great to permit of the various operations being performed without the possibility of the steel being burnt. Various difficulties arise, as, for instance, the necessity for a good and reliable flux, suitable for each material under treatment, and the great difficulty experienced in maintaining the arc when once formed, as it requires a man with a steady nerve to resist the almost uncontrollable impulse to give a jerk when the arc is first started, thus causing an unsteadiness which would be detrimental to good working; these difficulties, however, might be overcome in time. Seeing that sudden breakages of the circuit will occasionally occur under the best of management, it is necessary that the source of the current should be such that no damage may arise, such as overheating in the coils of the dynamo when an interruption does occur, which seems to point to the almost absolute necessity for a set of accumulators as an adjunct to the system; and the author cannot but think that its universal adoption will be prevented by the great outlay which is thus necessary for carrying out the system in a proper manner, as it is essential to good working that the current may be readily varied to suit the different circumstances, and that a powerful current of somewhat low tension should be used. An electro-plating dynamo, giving a large quantity of current, but of low electro-motive force, seems to be necessary for the purpose, in combination with a number of secondary cells or accumulators.

The writer is not aware that any experiments have yet been made with an alternate current, but should consider that it would not be so practicable, seeing that accumulators could not then be used. The process may be carried out under water, but this is accompanied by a violent ebullition in and decomposition of the water, and owing to the latter action gases are formed, which, if inhaled, might possibly be injurious.

From the experiments carried out in Russia, iron and copper, cast iron and steel, wrought iron and steel, have been firmly united together by the process. It is possible that if the arc were formed between similar metals—*i.e.*, if, in welding iron, the positive pole consisted of a rod of iron, in the place of the carbon hitherto used—the wasting away of the rod might be utilised to help to fill up the weld.

AN ENGINEER'S LIFE AT SEA.—III.

BY A SEA-GOING ENGINEER.

(Continued from page 69.)

Our young engineer, having got a general idea of the working of the engines, must now penetrate a little deeper into the matter. Beneath his feet lies a hidden world, which must be explored—the watery inferno of the bilges. The course of each bilge pipe must be traced and thoroughly understood, and, if necessary, visited again and again till there is no uncertainty remaining, and until the maze of crossing and winding pipes resolves itself into order. Not only must he know where and how the water enters these leaden pipes, but his mental vision, piercing through them, must follow it on its course through the cocks which guide it, through the pumps which act upon it and on which it acts, until he follows it through the copper discharge pipes into the sea. He will find that, however well he thought he understood the action of a pump, he has a thousand things to learn when bilge water is in question. He comes as a beginner, and at the end of his sea life he will find that he is a beginner still. Sometimes a bilge pump will baffle, for a time, the most experienced of engineers, though patience always conquers in the end.

A slight consideration will show how complex the subject is. The pumps are made to draw from at least six or eight different parts of the vessel, and for each pump, when one suction is open, all the others must be shut. Then there is a suction from the sea, and perhaps six suctions from the ballast tanks. The pumps are sometimes made to draw water from the sea, and discharge it through pipes on deck; while they can also be set to draw from the bilges and discharge into the sea. When it is remembered that for each purpose one set of cocks must be open and another set shut, and also that these pipes, which are connected to the pumps on the main engine, are also connected by branches to the ballast and donkey pumps, the necessity for accurate knowledge of them becomes clear. In addition to this, the ballast tanks are often run up through the same pipes which are used to pump them out, thus rendering the most careful attention imperative.

When the position and purpose of each pipe and cock have been thoroughly understood, our engineer will find himself confronted by new problems whose solution will often entail much labour, and will sometimes keep him in dripping clothes from much-desired rest. These pumps display a remarkable facility for ceasing work at inconvenient and unexpected moments; and when an engineer has made himself clean, and in imagination is already in his bunk, few things are more exasperating than to find that a bilge pump has stopped just when the relief watch is coming on. He has then to remain and put all in order for the new comers. This also deducts from his night's rest, for his next watch comes on, as he knows well, with the exactitude of fate.

In attempting to expose the mischievous tricks of the water sprite who makes his home in the bilge pipes and pumps, we can deal with little more than generalities, as no two bilge arrangements are precisely alike. Before the ship has been lightened by consumption of coal, the bilge discharges are frequently below water. It is then sometimes difficult to tell off-hand whether the pumps are working or not. The water may be heard rushing along through the discharge pipe, which by its coldness and its sound when lightly tapped is evidently full of water. But possibly this has come from the sea, through a leaky sea-discharge valve.

The suspicious clearness and abundance of the water through the opened pet valve should make the engineer look into the bilges to see if the pump is keeping the water down. Should the bilge water have increased since his last watch, then something is wrong. He slackens back the nuts on the valve-box cover, and the outrush of water tells of a leaky pump discharge valve, which is kept off its seat by some foreign substance under it, perhaps a bit of dirt or a chip of wood drawn up from the bilges. Then the sea discharge has to be shut down and the valves cleaned and replaced.

The following, which occurred fortunately in calm weather, is given as an illustration of the danger of discharges under water, with a hint to the reader that it is easy to be wise after the event. The steamer in question had—what is unusual—a stop valve instead of a cock on one of the suction pipes. Through this valve the forward bilge pump was set to pump the forehold dry. This being done, the stop valve was screwed hard down and the pump turned on the engine-room bilge. At daylight the next morning there was found to be about 3ft. of water in the forward hold, which fortunately was empty of cargo at the time. The two engine-room pumps were both apparently hard at work, and the only connection between the sea and this hold was through the forward pump. It was found that the dirt from the hold had got under the suction stop valve, preventing its shutting, though hard screwed down; dirt also had caused the valves of the pump to stick. All through the night sea-water had been running through these valves into the hold, and though it had also been getting into the engine-room bilge, yet the after pump had kept the bilge water at its usual level. This illustration is given only to those who may desire to learn from facts, and not to those superior persons who are above mistakes, and who are calmly confident that their knowledge and experience exhausts the universe.

When the discharges are above water, the engineer's anxieties and labours are lessened, as then a glance over the side before going on watch will tell whether the pumps are working or not, and will save disputes. If there is no discharge water coming out, he must look to see if the pump is drawing from the proper bilge, for with a heavy list, or with comparatively dry bilges, one of the boxes may be out of water. Should the suction be on this, which a look at the cocks will reveal, he must at once turn it to where the water is, for when a pump has refused duty near the end of a watch, an engineeer has been known to turn on a box out of water, in the expectation that it would not be altered till he was off duty. When, however, an engineer from any cause has had an unusually laborious or troublesome watch, it is by far the best policy, when telling his successor of it, to ask him to take the pump as it is, and so to share the work. This will rarely be refused. Should, however, the water be gaining materially, then the pumps must be restarted at any cost.

When a pump stops work it may sometimes be started again by pouring water on the plunger gland, or by letting it draw in water through the pet valve on the cover. Should this fail, then try the pet valve again. If it shows that there is little or no suction, the pump is drawing air. If the bilge box is covered with water, and if only the right cocks are open, some of the pipe joints may be leaky, or there may be a hole or split in the suction pipe; the delivery valve may be stuck open with dirt; the plunger gland may require tightening down; or the valve-box cover may be drawing air at the joint. These two latter may be detected by means of a lamp. If both suction and delivery be unfelt, the fault is, probably, on the pump side of the suction valve. Should the tap show a weak suction and full delivery, the fault is on the bilge side of the suction valve; and if there be a strong suction with the pump dry, then the suction valve is stuck down with grease, or the pipe is choked. Remove the cover, and if the valve can be raised easily, it has been held by grease and needs cleaning out. Should it be, apparently, glued to its seat, it is because there is a vacuum under it, due to the choking of the suction pipe. These give the merest outline of the reasoning and observation which are never wasted if spent on these pumps.

Sometimes rubber valves are used instead of brass ones. These are not so liable to choke, but have a variety of defects peculiar to themselves. A spindle usually passes from above through the delivery valve seat, which is made removable, and then it passes through the suction valve seat, and out through a hole in the bottom of the casting, where it is secured by a nut, washer, and rubber joint. Both valve seats are sometimes not tight, and the joint at the bottom of the casting has also to be carefully made. The cover on the top makes also an extra joint. The valves will sometimes split; sometimes the centre hole wears too large and overlaps the grating, or the whole valve flattens out too large for its seating; while occasionally, with a dirty bilge and the ship rolling, the space between the two valves may get full of bits of wood, cinders, &c. The writer remembers a ball of marline, that had been lost in the bilges, getting a great part of its length between the valves, and had twisted and knotted itself into a most extraordinary and tangled mass. The balance is, however, probably in favour of rubber valves as opposed to brass ones.

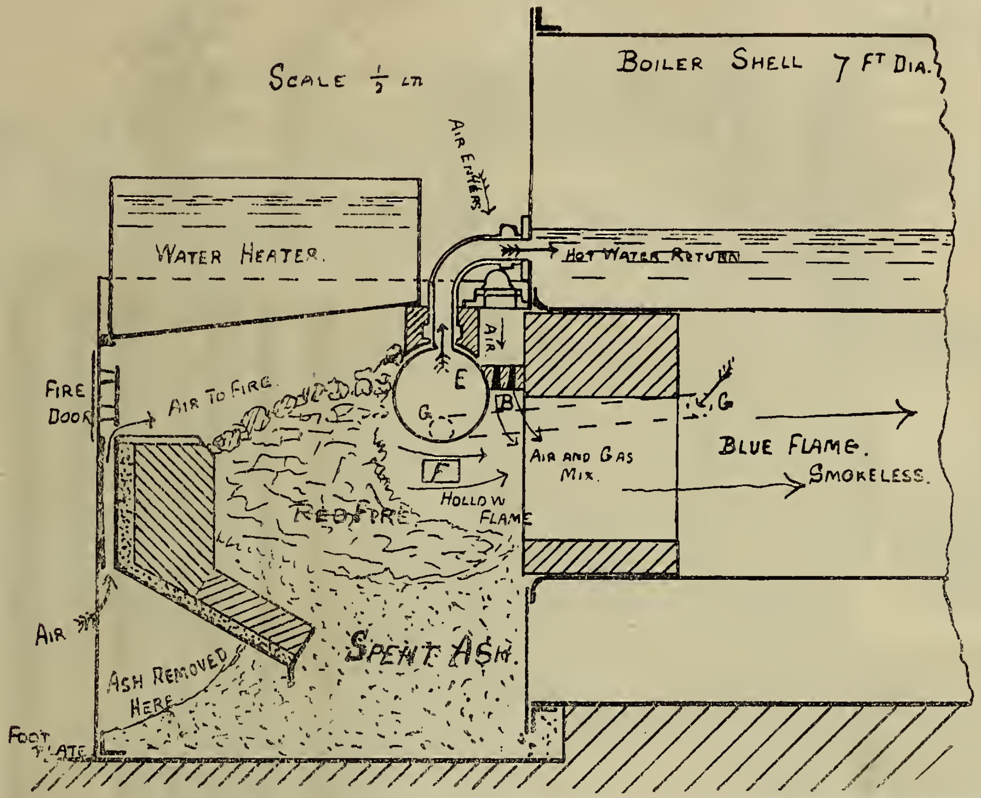
As to the dirt to be found in bilges. This depends largely on their construction, which sometimes by their comparative inaccessibility makes it difficult to watch the bilge lads in port, or by their extent makes it difficult for a thorough cleaning to be done in the time allowed. The tightness or otherwise of the stokehold plates, and the condition of the holds, all play their part. If much overhauling has to be done in a limited time, the extra mechanics put on will often not take the trouble to go into the bilges to look for anything dropped, and sometimes a missing spanner or hammer, or an assortment of nuts and bolts, will be found in this universal save-all; also cinders, chips, and spun yarn are sometimes met with by the adventurous explorer, and a floating block of wood has been known before now to break a bilge box or flatten a pipe. The union of grease from the engines, mixed with the water which has been used to cool the working parts, or which has come in through leaky seams in the vessel, forms black balls of grease, varying in size from a marble to a cannon ball. Some vessels are so well constructed and cemented as to reduce these annoyances to a minimum, while others in the extent and inaccessibility of their bilges are a constant source of trouble, in spite of every care and attention on the part of the engineers.

Electricity in Workshops.—Messrs. William Denny, of Dumbarton, are, it is said, about to instal the electric light in their workshops and shipbuilding yards.

Oil for Brick Burning.—An experimental test of the value of oil for brick burning is being continued in the West of America. The latest process is said to be devised by D. Y. Purington, at his kilns near Blue Island, Ill. To burn a kiln of 200,000 bricks he uses the crude, or waste oil, after the naphtha has been extracted. This oil is fed from a tank by a 2in. pipe to very simple burners in the arches. The burning was complete in sixty hours. The oil cost 80c. per barrel, but the quantity used is not stated. An American contemporary says one man only was required to handle the fuel, and the saving over the old method is estimated at "fully 33 per cent."

FINCH'S PATENT SMOKE-BURNING FURNACE.

CONSTRUCTED BY BENJAMIN FINCH, 110, WATERLOO ROAD, MANCHESTER.



Forty years have now passed since the celebrated Wye Williams created much excitement in Liverpool on the subject of smoke-burning by his important discoveries in connection therewith, and during the intervening time little that is new has been invented.

Our attention has recently been drawn to a smoke-consuming furnace, quite novel in construction, which bids fair to stand a good test and prove valuable to steam users in particular. The invention of Mr. Finch, consulting engineer, 110, Waterloo Road, Manchester, has been erected and in successful operation for the past six months at Brookfield Fustian Mills, Littleborough, and from the sample of flue dust taken from this boiler it seems evident that the furnace entirely burns all its smoke and consumes every particle of combustible matter contained in the coal, leaving no trace of soot in the flues, as proved by the flue dust we hold. This dust is simply carbonate of lime slightly tinged with oxide of iron, contained in the Lancashire bituminous coal used.

The objects attained by its adoption are: Perfect combustion of all fuel used; perfect combustion of all smoke; absence of all soot deposit in the flues; absorption of all effective heat generated; the exclusion of all cold air at all times from the flues; dispensing with all fire-bars and avoidance of their cost; no smokeless coal is required, it being too costly and is short of gas. Mr. Finch claims that this furnace will evaporate 12½lb. of water per 1lb. of coal, against an ordinary furnace evaporating 8½lb.; and that smoky Lancashire or Newcastle cobble coal is best.

The most serious pollution of air in large towns such as Manchester arises from the burning of common, bad coal, used under steam boilers. The weight of soot given out into the atmosphere is stated by a competent authority to be at least 1 per cent in weight of the coal burnt, and in many instances 3 or 4; thus it follows that at least 200 tons of soot per day in Manchester alone is allowed to pollute and darken the atmosphere, which could be entirely prevented, and ought to be enforced by act of Parliament. This soot is evolved at a waste of at least 30 per cent of the heating power of the coal used, which leaves ample margin for the investment of money profitably to prevent it.

In construction, this invention comprises the introduction of a fire box, excluding the air at bottom, front, and sides, leaving the top only at front A open, wherein the fuel is placed and the air for combustion enters and mixes with the fuel, being drawn down by the draught of the chimney. At the back of the fire a hollow metallic bridge E spans the front of boiler, and is supplied from the boiler at C with circulating water to keep it cool. This bridge serves to prevent the fuel being drawn into the flue beyond. Beneath the bridge an open space F is maintained all across, for the flame to pass freely to the flues. At this point an inspection hole is provided, and at the back of bridge at B, from above, jets of air are conducted through finely-perforated bricks, which are maintained red-hot, so that the air is heated before mixing with the gases, and, being supplied in regulated quantity, provides the oxygen necessary to decompose the passing white-hot flame, and convert it into carbonic acid gas, so doubling its temperature and volume, evolving all the heat of which the fuel is capable, and consuming all soot and smoke for ever from the gases emitted from the chimney.

The fuel, having parted with all its combustible matter, falls of itself on the bed of the furnace and sustains the fire in position above it. This ash is drawn away periodically from the front ashpit at D on level of foot-plate, without disturbing combustion or breaking up the fire above it.

This furnace is applicable to all heating or evaporating purposes, such as land or marine boilers; all chemical evaporating, or salt pans; brewers' and distillers' pans; forge furnaces; smelting of copper, tin, lead, silver, &c., &c.; reheating furnaces, pottery kilns, ovens, warming buildings, &c.; in fact, in all cases where absence of smoke, economy of fuel, and great heat is wanted. A good sharp chimney draught is desirable.

The Khattan Oil-Fields, India.—Four wells have been sunk, two of which are 500ft. deep, and from all four a fairly plentiful supply of thick black oil is being pumped. This oil is of the consistency of treacle; and, although unfit for illuminating purposes, it is nevertheless very valuable, as is has been tried with perfect success for firing locomotive boilers as a substitute for coal and wood. It was only hoped that a sufficient supply of oil would be obtained to work the Sibi-Quetta section of the North-Western Railway; but the results of the borings now show that the whole of the North-Western Railway can be supplied. The great question now is how the oil can be best transferred to the railway. The nearest railway station to Khattan is Baber Kach, some thirty miles north of Sibi, on the Sind-Pishin Railway.—*Indian Engineering.*

IMPROVEMENTS IN ECONOMISERS.

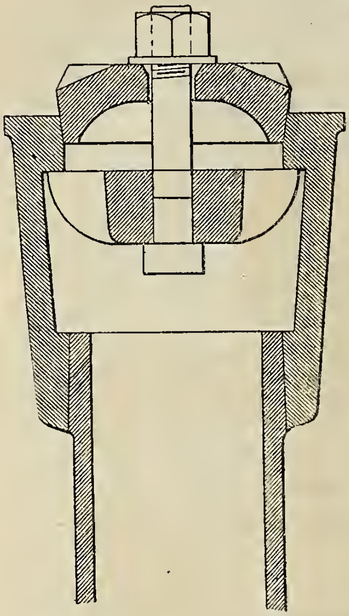


Fig. 1.

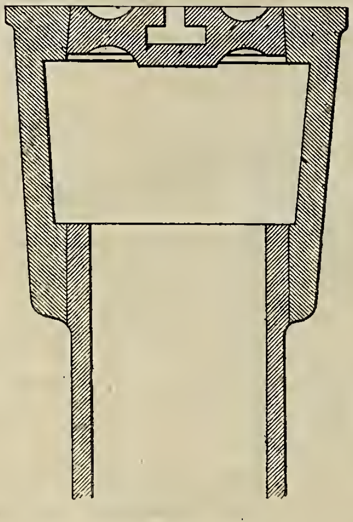


Fig. 2.

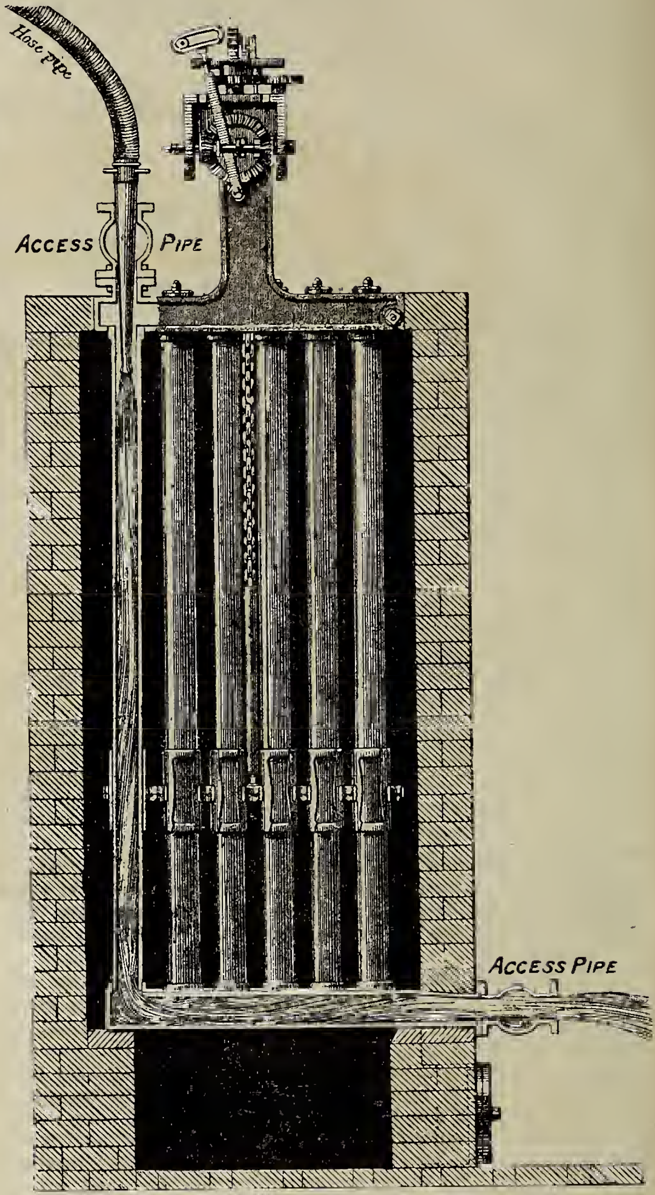


Fig. 4.

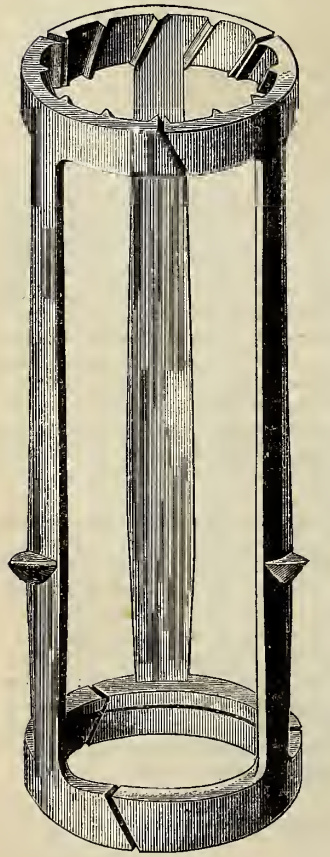


Fig. 5.

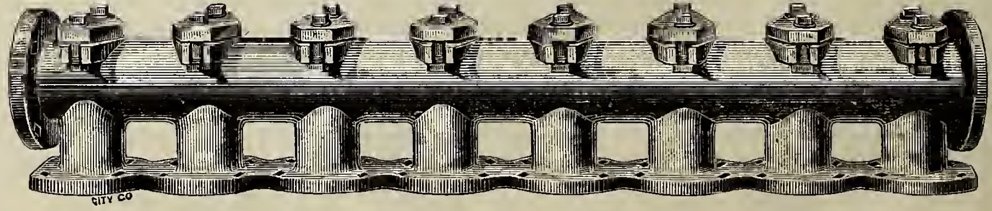


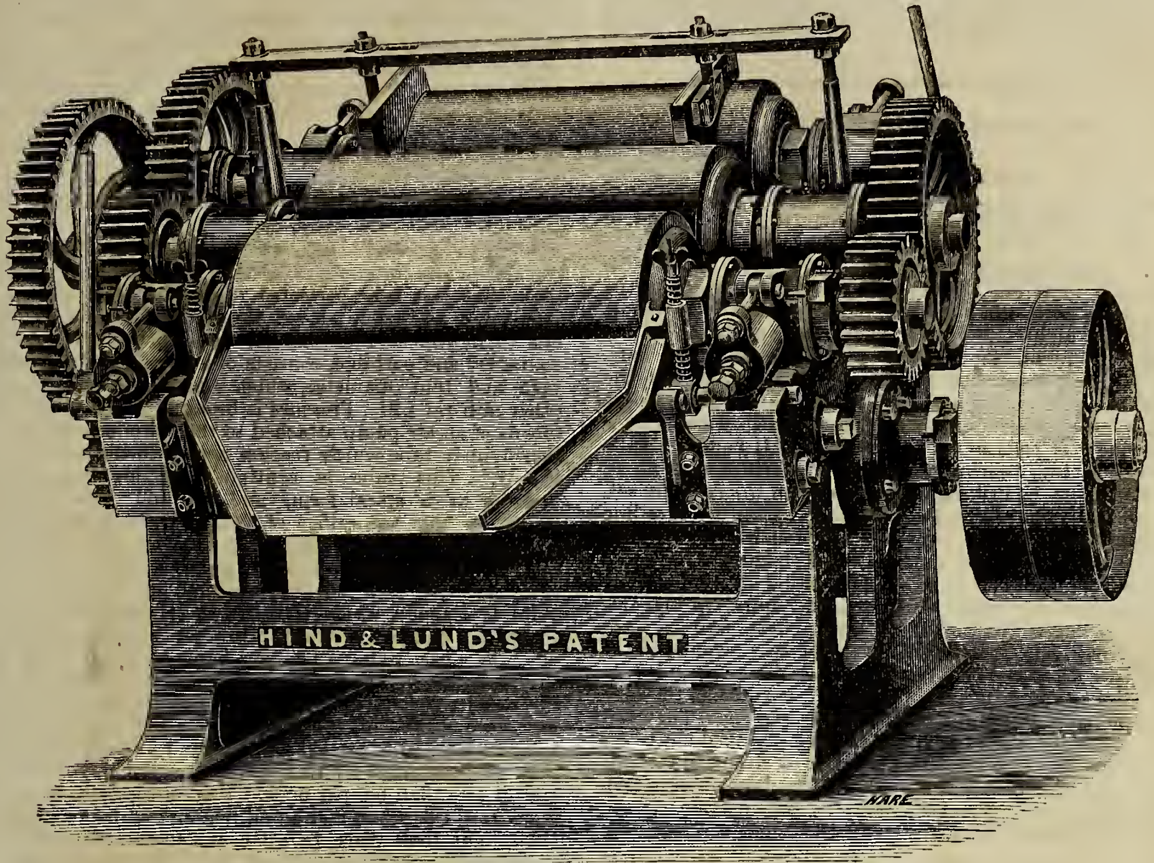
Fig. 3.

The utilisation of the waste heat from the flues of boilers has been very effectually and satisfactorily brought about by the use of the apparatus commonly known as "Green's Economiser." The fact is so well understood and appreciated that the "Green's Economiser" may be said to be almost as well known as the Lancashire Boiler, and we believe the total number now working may be estimated at 10,000 to 11,000. Since its first introduction, over forty years ago, this economiser has held the field against all competitors, and its history is almost unique, in that it has undergone no radical change in its principle of working, nor yet in its construction, and even in the matter of details the only variations up to within the last three or four years appear to have consisted in alterations in the form and gearing of the scrapers. Indeed, judging from the very many kinds of scrapers tried at different times, this would appear to have been considered the only vulnerable part. Amongst the scrapers that have at one time or other been used may be mentioned the "Whole Ring," the "Barrel," the "Crab Jaw," the "Spectacle," the "Triple," and the "Dentated." The last named, which is one of the latest developments, and is claimed to possess

PATENT PAINT MILL.

CONSTRUCTED BY MESSRS. HIND AND LUND, ATLAS WORKS, PRESTON.

(*For description see page* 128.)



the greatest advantages, is illustrated herewith and described below.

The great immunity from defects and failure which have characterised the machine appears to have precluded all necessity for improvement in it, and until a very recent date it has enjoyed the reputation of being perfectly safe and incapable of creating any serious disaster. Of late years, however, whether owing to a large number of economisers having served more than a reasonable length of time and being far worn, or to the higher pressures now carried, or to other causes, several economiser explosions have occurred. These accidents, although justifying alarm as to the condition of a large number of economisers now at work, should not be allowed to engender distrust in an apparatus which has proved of such immense benefit, and which, we feel sure, may with reasonable care continue to be used as safely as before. But the explosions do point in no uncertain way to the urgent necessity for complete and reliable inspection of economisers, and for this purpose certain structural alterations are essential. With a view to directing the attention of the steam-using public generally to these matters, we propose laying before our readers various improvements that are now being made, and it is with pleasure that we are able to state that Messrs. Green, the original inventors of the economiser, not only recognise the need of further facilities for inspection, but are now active in perfecting and bringing out the required alterations.

One of the difficulties experienced has been in removal of caps for internal examination of the vertical pipes, the caps hitherto used being in form of a conical plug, fitting into a seating, and held in position by a central bolt and internal crossbar. After an interval of time these caps are usually found to be so fast in their seatings that they cannot be withdrawn except by very great efforts, occasionally resulting in fracture of the top boxes. Preparation is thus a matter of some risk, and internal inspection has been in consequence far less frequent than is advisable or essential to safety. The importance of such examination, especially where the water is either sedimentary or of a corrosive nature, is too apparent to require comment here. To surmount the difficulty Messrs. Green have brought out a cap of similar conical form, but inserted from inside the top box, and kept in position by the pressure of the water in the economiser, without the assistance of bolt or crossbar. To remove the cap it is simply knocked down into the top box by a blow with a hammer, and to replace it a lifting key is inserted into the top of the cap, which, being slightly conical, a slight upward pull or jerk suffices to keep it in position until the economiser is filled with water, when the pressure retains the cap firmly. Fig. 1 shows the old cap, and fig. 2 the new one.

A further improvement in the same direction consists in having the horizontal connecting pipes at the top and bottom of the economiser provided with openings opposite all the connecting branches, each opening being covered by a small cap with two bolts, as shown in fig. 3. This alteration admits of the interiors of the bottom boxes and of the vertical pipes under the top horizontal pipe, which were previously inaccessible, being examined. It also serves a further purpose, as it provides a means of washing out the bottom boxes (where the deposit mostly accumulates), as shown by fig. 4. It is claimed that a stream of water played through each bottom box, in the manner illustrated, removes the deposit much more effectually than can be done by the use of the blow-out, as the latter, draining as it does the whole of the pipes at the same time, produces only a very slow movement of the water in each.

Fig. 5 illustrates the "Dentated" scraper. The mode of suspension by conical pivots is stated to keep the scraper in close contact with the pipe, while the action of the inclined teeth at the top end, and of the sharp-edged clip at the bottom end, in removing the soot, is sufficiently apparent.

In addition to the above details, alterations have been made in the arrangement of the economiser to facilitate inspection in the flue. The flue is made of sufficient width to allow a passage between the pipes and wall at each side of the economiser, and deflecting dampers, on hinges or pivots, are placed at intervals to throw the heated gases amongst the pipes. The economiser is also divided into lengths or groups, each containing about a dozen sections of pipes, placed a sufficient distance apart to leave a transverse passage between them, and are connected by pipes made in horseshoe form, thus providing for expansion and contraction. We hope to be able to illustrate these further improvements in a future issue.

The alterations we have recorded are steps in the right direction, and for the reasons already given, and in view of the proposed Boiler Inspection Act, in which boilers and economisers are to be alike included, their importance to steam users cannot well be exaggerated.

PATENT PAINT MILL.

The paint mill illustrated above possesses some new features, which makes its performances much superior to the generality of mills. It is manufactured by Messrs. Hind and Lund, of Preston, who have paid special attention to this kind of machinery. The bearings are specially designed to be self-lubricating, and to retain the oil and prevent it getting on the rolls, or mixing with the material being ground. For most purposes it is highly desirable that the rolls should be kept free of oil—as, for instance, in grinding chocolate, starch, white lead, paint, &c. There are three rolls, and the bearings of the centre one are fixed, while the outside ones are provided with swing bearings for the purposes of adjustment. This kind of bearing has been found to give more satisfactory results than a simple sliding bearing. The swing bearings work on an eccentric, which can be locked in position when the rolls are set, which operation is done after setting the rolls by use of a levelling plate. Readjustment can be easily effected whenever required by simply unlocking the eccentrics, and turning them slightly in the right direction till the plate is level, and locking up again. The setting up is done by means of screws, and spiral springs are provided, which allow the rollers to spring back when a hard foreign substance gets in the machine, and so prevents, or at least minimises, damage to the rolls. A handle is provided on the side of the machine for the purpose of separating the rolls when the machine is standing, so as to avoid clogging. They can be brought back to their original position immediately by turning this handle, without the necessity of fine adjustment. The rolls are of the best granite (30in. long, 14in. diameter), turned and polished in the best style by the makers of the machine, who have special machinery for this purpose.

WAGES IN BELGIUM.

A report on the rates of wages in Belgium and the condition of the working classes there generally has been published by the Board of Trade. It is based on the report of a Belgian Labour Commission, appointed by royal decree some time since to inquire into the subject, in consequence of the labour disturbances. The report includes detailed statements relating to particular industries. Messrs. John Cockerill and Co., of Seraing, give a return showing a material decline in wages against 1875, but very little change against 1872. Coalminers, for instance, earned 2s. 5d. per day in 1872, 3s. 4½d. in 1875 and 2s. 4¾d. in 1886. Blast furnace workers earned 2s. 2¼d. per day in 1886, against 2s. 7½d. in 1875 and 2s. 5d. in 1872. Boilermakers, on the other hand, earned 2s. 6½d. per day in 1886, against 2s. 10d. in 1875 and 2s. 5½d. in 1872. The wages of forgemen and hammerers, 2s. 9¾d. per day, though lower than in 1874-5, are precisely the same as in 1872. This company, the greatest engineering concern in Belgium, reports that in general wages have really increased or decreased in accordance with the increase or decrease in the price of the article produced. A table of wages in the zincworks of Vielle Montagne shows a decided advance since 1854, at least up to 1885, which in one case has been continuous, though in others there has been a slight giving way since 1875. Thus in the Angleur works the rate paid has latterly been 2s. 10d. per day, against 3s. 0¼d. in 1875 and 2s. in 1854; while in the Valentin Cocq works the increase has been from 1s. 5½d. per day in 1854 to 2s. 10½d. per day in 1885. This rise of wages in spite of a decline of prices meanwhile is attributed to an increased output by means of improved machinery. The wages of miners, smiths, enginemen, carpenters, and others at the Bleyburg works are returned at 1s. 9½d. per day in 1885, against 1s. 4¾d. per day in 1855; and the wages of founders at 2s. 6½d. per day in 1885, against 1s. 7¼d. per day thirty years earlier. The wages of head founders in the Seraing district are stated in another return as 6s. 9½d. per day latterly, against 5s. 2½d. per day in 1865; and those of enginemen at 3s. 0½d. per day, against 1s. 11d. in the earlier year; while moulders are said to earn from 3s. 4¼d. to 5s. 2½d. per day, against 3s. 4¾d. to 4s. 4¾d. in 1870.

In considering the present material condition of the Belgian working classes on such wages, due attention must be given to the decline in the cost of living. While it has been pretty clear that wages generally have declined since the period 1873 to 1879, it is equally clear that they are higher to-day than they were twenty or thirty years ago. And with this improvement in the rate of payment there has been a decline of prices which probably has put the average worker in a position at least as good as that which he held during the period of maximum wages.

THE DOTY LIGHT.

A very useful and cheap self-generating light for illuminating workshops and for enabling outdoor operations to be carried on at night has just been perfected by Captain Doty, who will be remembered as having solved the problem of employing mineral oils in lighthouse illumination. The Doty light, which is self-contained and portable, consists of a galvanised iron cylinder 2ft. high and 18in. diameter, which contains a supply of paraffin or other mineral oil. Pressure is brought on the top of the oil by means of an air pump attached to the cylinder, and the oil is thus forced up a tube which reaches nearly to the bottom of the oil supply. This tube is continued outside the top of the cylinder in a spiral form, and the end is continued downwards, so that the orifice of the tube is in the centre of the vertical coil, and constitutes the burner. The lamp is lighted by first heating the coil by a small oil flame to the temperature necessary for the vaporisation of the oil. When this point is reached, which is in three or four minutes, the oil is turned on, and upon entering the coil is at once vaporised and burnt as a gas, giving a brilliant flame some three feet high. As the flame originates at the bottom of the coil and passes up through its centre, it keeps the coil hot, and the conversion of the oil into gas goes on continuously. The working air-pressure is from 10lb. to 15lb. per square inch, and a 500 candle power light, it is said, will burn for 13 hours with one charge of oil, and at a cost of less than 6d. per hour. The air-pressure requires renewing about every two and a half hours. A demonstration of the Doty light took place recently at Messrs. F. Braby and Co.'s works at Deptford, when two of the lights were shown to illuminate a store 200ft. long by 40ft. wide.

FOUNDRY DESIGN.

Strong high walls are best for a foundry, and lumber should not be used in construction, except where absolutely necessary. Any foundry worth building at all is worth building well. Speed, convenience, and durability should be the chief aims in laying out a foundry plant.

Dry sand work will probably be in demand as long as the present system of working metals in a foundry is in use, and therefore provision should be made in building a foundry to produce this class of castings as cheaply as possible. Pits, either of iron or brick, must be built in some portion of the main floor, for the purpose of laying up loam work, and in many cases drying the same in place. The portion of the foundry set apart for loam moulding should be encased with water-tight walls, and the bottom of this compartment should also be laid with water-tight material.

If the foundry is to be a large one, say 50ft. wide and 200ft. long, a space of 50ft. by 70ft. should be arranged at one end of the building for making all classes of loam and dry sand castings, and this whole space would be enclosed below the floor line, as described above. Within this space can be placed iron and brick curbs for special work, while the entire compartment can be filled in with moulding sand.

For a foundry of this size, there should be four core ovens, three of which would be rectangular in form, of the following dimensions: one 12ft. by 20ft., one 8ft. by 15ft., and one 6ft. by 9ft. The fourth oven should be a circular one, 5½ft. diameter, and 8ft. 6in. high. The two largest ovens should be located and in direct connection with the loam moulding department, and the small rectangular and the circular ovens should be placed at the other end of the foundry, which is set apart for small castings, snap moulding, &c. Assuming that the traverse crane system is adopted, a wide and a narrow traverser side by side are preferable to one wide and one extending the whole width of the building. The wide crane should be placed on the side nearest the cupolas, and the tracks extended 150ft. from the loam moulding end of the foundry, while the narrow crane should have its tracks extended 105ft. from the same end of the building, or enough only to reach the cupola jib crane. The two large core ovens should have a railway track in each, connecting with the main track in the foundry, and each oven should have its own heating furnace. In the space not occupied by the two traverse cranes the most modern and convenient wall and jib cranes should be placed, arranged to swing under the wide traverse crane at several points in the length of the track.

The core ovens and cupolas should always set back clear of the main walls of the foundry, and should be located in separate compartments, with ample space around the cupolas, both on the ground and platform floors, these floors being composed of cast gratings.

The roof should be a riveted iron plate truss, carrying one-half of the load on the cranes by a suspended truck hung from the roof trusses, the other half being carried on the walls of the building. At the loam moulding end of the traverse tracks there would be one central column placed under the central track, as at this point both cranes can be used in connection with each other, making a combined hoisting capacity of 22 tons, the wide crane being 14 tons and the narrow one 8 tons capacity.

This foundry should have three cupolas, two being at or near the centre of the building's length, and the third should be placed conveniently near the end allotted to snap moulding and other small castings. The small cupola should be able to melt 3 tons, and the two large ones combined 25 tons, for an afternoon's work. The power for driving blowers, flask-shop machinery, traverse cranes, power jib cranes, rattler, drop, &c., should be derived from an independent steam plant, located in a building connected to the main foundry. The boiler should be large enough to heat the foundry in the cold season, the lower or discharging ends of the steam coils being connected with a receiver and small air pump, to induce perfect circulation in all of the coils, and at the same time continuously free them from water.

The cleaning room should be directly connected with the main railway track in the foundry, and should be near the end in which the green sand work is done. This room should be provided with one good jib crane, and an endless overhead single track, with three travelling trolleys thereon.

The core making should be kept out of the main body of the foundry as much as possible; therefore a room of liberal size should be built in a central position, for the exclusive use of the core makers.

The pig iron lifts for the cupolas should all be hydraulic, and the pumps operating these should act as fire pumps also. The flask making should be done in a building isolated from all others, and this shop be furnished with the necessary plain woodworking machinery. The drop for breaking up old castings should always be operated by power, and there are many simple methods of doing this work.

The foreman of the foundry should have a room located near the centre of the buildings, to be used as an office and testing room, for in this room there should be a standard testing machine. At each heat there should be a set of bars cast from each cupola, if the mixtures are different, and these bars should be broken by the foreman every morning after a cast. In this way a watch can be kept on the material, and if the quality is falling off the makers can be notified, thus preventing future trouble and expense.

Although it is necessary to have quite a number of patterns in the foundry at all times, yet, as a general rule, there are more patterns stored, as it were, in the foundry than there should be. There should be a system of removing a certain number of patterns every day to the fireproof pattern lofts, for it will pay in the matter of repairs as well as safety.

The arc and incandescent systems can both be used to advantage.—*American Machinist.*

HYDRAULIC MORTARS AND CEMENTS.

In an article on the constitution of hydraulic mortars and cements in the *Annales des Mines*, M. H. Le Chatelier shows that the ordinary seven days' to one month's tests of hydraulic cements are extremely unsatisfactory methods of determining the constructive value of these materials, as the strength of such substances not unfrequently decreases after a more prolonged hardening. Chemical tests are also said to be unsatisfactory, and in fact the only plan really insuring good results is to employ a cement similar to one that has already undergone the test of practical experience in existing works. An approximation to the results obtained in examining such works can however be realised by making the seven days' test on briquettes which have been allowed to set for twenty-four hours in air at the ordinary temperature, and have then been allowed to harden, for the six days remaining in a water bath at a temperature bordering on 212 deg. Fahr. Care must, however, be taken that the water of the bath does not actually reach the boiling point, as in such a case the briquettes are liable to be disintegrated by bubbles of steam. If in addition to the above these tests are completed by desiccating the cement in dry air at 212 deg. Fahr. before testing, a very fair idea of the comparative value of the product will be obtained.—*Engineering.*

A NEW HECTOGRAPH.

A new hectograph of German invention, says the *Engineer and Iron Trades Advertiser*, is made from a sheet of blotting paper, which has been soaked in a solution consisting 4 parts of gum, 5 of pure water, 3 of ammonia, 3 of sugar, and 8 of glycerine. The gum is first dissolved in a mixture of the water and ammonia, which is then heated to boiling, and the sugar and glycerine added. The hot solution is then spread over the paper with a brush, and left to dry during a period of three days. When used, the paper should be damped with a sponge and left one or two minutes. The drawing or writing to be copied is placed over the copying paper face downwards, and pressed with a roller or the hands. After one minute it is taken away and a sheet of paper substituted, on which the drawing is copied, by simple pressure with the hands, as previously described. Several copies can be obtained from an original, and the same copying can be used for reproducing other drawings after a period of twenty-four hours.

UNITED STATES GOVERNMENT RULES FOR MARINE BOILER PRESSURES.—III.

Continued from page 92.

LAP-WELDED FLUES.

Lap-welded flues, 16in. and not less than 7in. in diameter. To determine the pressure per square inch allowable on lap-welded flues 18ft. and less in length, multiply the thickness of material in hundredths of an inch by the constant whole number 44, and divide the product by the radius of the flue in inches; the quotient will be the pressure allowable.

For every foot or fraction thereof over 18ft. deduct three pounds per square inch from the pressure allowable on a flue 18ft. in length, or add $\frac{1}{100}$ of an inch to the thickness of the material required for a flue 18ft. in length for every 3ft. or fraction thereof over 18ft.

To determine the thickness of material for any required pressure, multiply the pressure in pounds by the radius of the flue in inches, and divide the product by the constant 44; the quotient will be the thickness required.

The thickness of lap-welded flues shall not be less than the product of the constant 2·20 multiplied by the diameter of the flue in inches, which will express the thickness in hundredths of an inch.

Lap-welded flues 7in. and not over 16in. in diameter, over 5ft. and not over 10ft. in length, shall be re-enforced by one wrought-iron ring attached externally at the centre of the flue.

Lap-welded flues over 10ft. and not over 15ft. in length shall have two wrought-iron rings attached to the flue externally, equidistant between the ends of the flue, and there shall be attached one additional ring for every 5ft. or fraction thereof over 15ft. in length.

All such rings shall be good and substantially made, and properly and securely attached to the flues, and shall have a thickness of material not less than the thickness of material of the flues, and a width of not less than 2½in.: *provided, however,* where such flues are made in lengths of not over 5ft. and fitted one into the other, and substantially riveted, the wrought-iron rings may be dispensed with.

Lap-welded flues 7in. in diameter and less shall be in accordance with the following table of thicknesses: *provided, however,* that all lap-welded flues 16in. diameter, and not less than 7in. diameter, when used under a steam pressure of 120lb. and upwards, shall be of the same thickness as prescribed in table, rule 2, section 8, for riveted flues.

Diam. in Inches.	Thickness in Inches.	Diam. in Inches.	Thickness in Inches.	Diam. in Inches.	Thickness in Inches.	Diam. in Inches.	Thickness in Inches.
7	·165	4	·134	3	·109	2	·095
6	·165	$3\frac{3}{4}$	·120	$2\frac{3}{4}$	·109	$1\frac{3}{4}$	·095
5	·148	$3\frac{1}{2}$	·120	$2\frac{1}{2}$	·109	$1\frac{1}{2}$	·083
$4\frac{1}{2}$	·134	$3\frac{1}{4}$	·120	$2\frac{1}{4}$	·095	$1\frac{1}{4}$	·072
						1	·072

For cylindrical boiler flues over 16in. and less than 40in. in diameter, the following formulas shall be used in determining the pressure allowable :—

Let D = diameter of flue in inches.
1760 = A constant.
T = thickness of flue in decimals of an inch.
P = pressure of steam allowable in pounds.

$$\frac{1760}{D} = F, \text{ a factor.}$$

$$·31 = C, \text{ a constant.}$$

$$\text{Formula}: \frac{F \times T}{C} = P.$$

Example.—Given a flue 20in. in diameter, and ·37 of an inch in thickness ; what pressure could be allowed by the inspectors ?

$$F = \frac{1760}{20} = 88; \text{ then, } \frac{88 \times ·37}{·31} = 105 + \text{ pounds as the allowable}$$
pressure.

CORRUGATED FURNACE FLUES.

The strength of corrugated flues, when used for furnaces or steam chimneys (corrugations not less than $1\frac{1}{2}$in. deep), and provided that the plain parts at the ends do not exceed 6in. in length, and the plates are not less than $\frac{5}{16}$ of an inch thick, when new corrugated and practically true circles, to be calculated from the following formula :—

Let T = thickness in inches.
D = mean diameter in inches.

$$\text{Allowable pressure} = \frac{12500}{D} \times T.$$

Example.—A flue 40in. in diameter, and $\frac{1}{2}$in. thick would be allowed a pressure of $\frac{12500}{40} \times \frac{1}{2} = 156 +$ pounds per square inch.

The formula for cylindrical lap-welded and riveted flues in boilers to be used as furnaces, which shall be used by inspectors in determining the pressure to be allowed, shall be as follows, viz :

Let D = diameter of flue in inches.
89600 = A constant.
T = thickness of flue in decimals of an inch.
L = length of flue in feet, not to exceed 8ft.
P = pressure allowable, in pounds per square inch.

$$\text{Then } \frac{89600 \times T^2}{L \times D} = P.$$

Example.—A flue 40in. in diameter, 7ft. long, and $\frac{1}{2}$in. thick would be allowed on a steam pressure of

$$\frac{89600 \times ·5 \times ·5}{7 \times 40} = 80 \text{ pounds per square inch.}$$

Provided, If rings of wrought-iron fitted and riveted properly on, around, and to the flues, in such manner that the tensile strain on the rivets shall not exceed 6,000 pounds per square inch of section, the distance between the rings shall be taken as the length of the flue in the formula.

CORRESPONDENCE.

We do not hold ourselves responsible for the opinions of our Correspondents.

BOILER REGISTRY AND INSPECTION BILL.

To the Editor of " The Practical Engineer."

Sir,—Will you please find room in your useful paper for a few plain statements and questions regarding the agitation got up by your last few weeks' back correspondent, "Public Interest," who seems to be very anxious that this precious certificate for the enginemen and stokers should become law. I think if "Public Interest" were to answer a few plain questions, and say what the requirements of the engineman and stoker are to qualify them for a certificate of the Board of Trade, his letters would give greater satisfaction. Firstly, would he have a man who has been in service say ten, fifteen, or twenty years to be bound to go through a severe examination in mathematics to qualify him as a fit and proper man to be in charge of engine and boiler, though he has proved himself to be a competent man in his years of service? Would he have that man who had made the engine and boiler his one care and practice dismissed simply because he cannot work the problems of the so-called requirements of the Board of Trade certificate? I would ask "Public Interest" if he would have theoretical men, with their figures and paper, and perhaps not an hour's experience with either boiler or engine, in preference to practical men? I contend that he has outstretched the bounds of reason when he says that if a man fears the Board of Trade certificate he is just the man who ought to be dismissed. I ask him if it is not natural for him to care, after toiling and sweating for years, and doing his work satisfactorily both to masters and to the interest of the public as well, to think that now he is no longer fit to be trusted, and must consider himself unqualified for work, and his family must look to "Public Interest" for bread. Again, is "Public Interest" prepared to tell the owners of steam engines and boilers that these certificated men will infallibly guarantee that boiler explosions shall be things of the past? I think that the interest of of the public has been in the background, and that the whole of humanity has suffered more through certificated men than anything else.—Yours truly,

Steeton, Yorkshire. **Alfred Mosley.**

To the Editor of " The Practical Engineer."

Sir,—In reference to the letter in your last issue, I see that the shoe seemed to pinch one who signed himself "Working Engineer," but who ought to have signed himself "Wanted to be an Engineer." Sir, if I have insulted those men to whom your correspondent refers, I beg their pardon, but do not think I have, because if any practical man read my letters he could convince himself; but according to "Working Engineer's" statement we shall still have to go on in the old way, and chance being blown to atoms by that sort of men. As regards a man managing an engine and boiler for twenty years, I still believe, as I said before, he need not fear an inspection in the least, but ought to be glad of it, because then he could say to himself, "I don't care now I have been examined ; I have got my certificate for life, and no matter where I go my master will know that I am a competent man." "Working Engineer" winds up by saying that he thinks "Public Interest" is "one who has nothing to do but find fault with those who do the work." I should like to let him know that perhaps I am at work more hours than he is, and when I am there I study my work and my fellow-workmen—rather, I might say, enginemen. My motto is, "Pay a man what he is worth, whether he be first class, second class, or third class."—I remain, yours,

Leicester, March 10th. **Public Interest.**

To the Editor of " The Practical Engineer."

Sir,—In *The Practical Engineer* of March 2nd, there is a letter by "Public Interest," which states that any engineman who has had the charge of steam engines and boilers for twenty years or so, who is afraid to pass a Board of Trade examination, is just the man who ought to be dismissed at once. This letter has aroused the attention of one who signs himself "Working Engineer" in your paper March 9th, who considers the above a gross insult to engineers of twenty years' standing. Now, sir, I think "Public Interest" would do more good if he were more reasonable in his remarks. He ignores the practical abilities of enginemen altogether, and considers that he who possesses the theory of engines and boilers is better qualified for that work than one who has had charge of engines and boilers for 20 years, and worked them in a creditable manner. Now, sir, with this I cannot agree, but believe the reverse. As I get among many engineers, I find what is most wanted by them is Government inspection of all boilers, whether stationary or otherwise ; and all repairs deemed necessary by them, or a reduction of pressure, to be binding on the owners to carry out—anything beyond this will meet with considerable opposition. If boilers were examined by Government inspectors, I believe there seldom would be such a thing as a boiler explosion. M. Y.

Huddersfield, March 13, 1888.

POLLITT AND WIGZELL'S ENGINES.

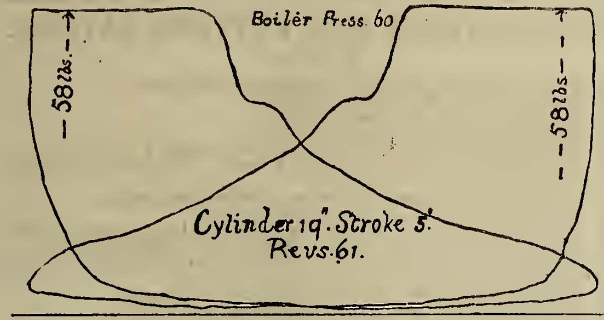
To the Editor of " The Practical Engineer."

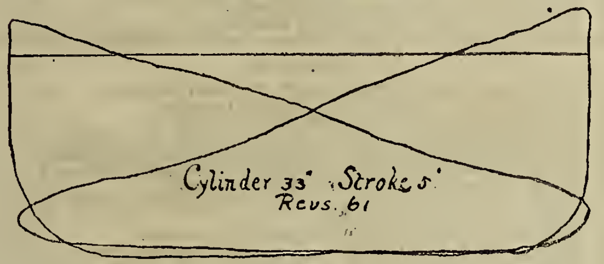
Sir,—I am pleased to see the letter of your correspondent "R. B." on the above subject, which is full of points, and shows clearly that the writer understands what he is writing about, and if this correspondent had signed himself "Study," in place of your other correspondent, it would have been a fair signature, as I feel sure that his letter indicates that the subject has been thoroughly and at the same time faithfully studied out by him. "Study" wants to know how many of P. and W.'s diagrams I have seen ; if he will kindly call on me I shall be glad to give him a few for his examination, and I feel sure they will be of great benefit to him in his studies. I should also like to point out to "Study" that, though my friend did come from a brickyard to his present place (where he has now been for thirteen years), no doubt some of the best engines in Yorkshire may be found in brickyards. Then he says that some of P. and W.'s engines are doing a great deal better than 3lb. h.p. per hour. Now, if "Study" will only favour you and your readers with all particulars of one in Bradford that is doing so, it will be a great aid in this discussion. Some parts of his letter are not worth answering, as most of your readers will agree, and if he will write in a more friendly spirit he will, no doubt, give greater satisfaction to the readers of *The Practical Engineer.* J. H.

Dudley Hill, March 12, 1888.

P.S.—I might say that the engine mentioned in my last has only slide valves, and no cut off in l.p.

The following are reduced copies of the diagrams forwarded by "J. H.," and referred to on pages 106 and 117 of our last two issues respectively. The scale can be ascertained by measurement, the steam line of first cylinder showing 58lb., and vacuum of second barely 12½lb. The cylinders are 19in. and 33in. diameter respectively, stroke 5ft., revolutions per minute 61, boiler pressure 60lb. [Ed. *P. E.*





TALLOW CUPS v. SIGHT-FEED LUBRICATORS.

To the Editor of "The Practical Engineer."

Sir,—In your issue of 2nd inst. "Sight-Feed" has made a few remarks respecting the sight-feed lubricator being more economical than the tallow-cup process. I will feel much obliged if he will state how many of these lubricators he has had to deal with, the kind of lubricant he uses, and the price of the lubricant. I am of opinion that, with very good lubricants, the sight-feed will work exceedingly well, but with bad, worse than the old tallow cups. If "Sight-Feed" will answer the above, I will take it as a favour, as, having about one hundred engines under my control, by adopting them it might be a great saving.—Yours respectfully, Eureka.

March 9th.

THE OXFORD ROAD (MANCHESTER) BOULDER.

To the Editor of "The Practical Engineer."

Sir,—The immense boulder raised in Oxford Road, Manchester, a few weeks since, and now placed in Owens College quadrangle, its resting-place, is stated by Professor Boyd Dawkins to weigh between twenty and thirty tons. Upon this authority the press called it thirty tons.

I am indebted for the following data to a correspondent of a Manchester weekly paper. He, with a friend, measured the stone, and, giving liberal measure, found it to be 7ft. × 6ft. × 4ft. = 168 cubic feet. The stone, if immersed in water, would displace about 10,416lb. of water, and as the specific gravity is about 2·7, the weight of the stone comes out 28,123lb., or twelve tons eleven hundredweight.

The above calculations show that Professor Dawkins' twenty to thirty tons is far from the mark, and I think he might have been more careful before giving the press and the public such an inaccurate estimate.—I remain, yours truly, D. R.

March 12th, 1888.

QUERIES AND REPLIES.

Copper Cylinders.—Could any reader kindly give me a simple, but reliable, formula for the collapsing pressures of copper cylinders subjected to external pressures? The dimensions of the cylinders vary from 12in. to 36in. in length, and from 12in. to 36in. in diameter. They are made of sheet copper with a single-riveted lap joint, brazed. They are flanged at the ends, the flanges being put on to receive bolt holes, not to strengthen them. The external pressure is the pressure of the atmosphere, there being a vacuum inside the cylinders.—Old Finsburian.

Answer.—In answer to "Old Finsburian," as to the strength of copper cylinders to resist external pressure under the conditions he mentions, I beg to give the following formula:

Where d = diameter of cylinder in inches
l = length of cylinder in inches
t = thickness of metal in inches
P = the collapsing pressure of the cylinder in pounds per square inch.

$$P = \frac{1312600\, t^2}{d\, l}$$

As the above value of P is the collapsing pressure of the cylinders, they ought not to be subjected to more than one-fifth or one-sixth of that amount of pressure, as a permanent set is given to the metal and its elasticity injured by a pressure much below that at which collapse takes place.

If admissible, I would suggest stiffening rings of T iron, at say about nine or ten inches apart, either on the exterior or interior of the cylinders to which the copper shell may be attached, for giving them greater stiffness; or the copper shell might perhaps be corrugated, the corrugations to be in planes at right angles to the axis of the cylinders, and thereby adding greatly to its stiffness.—W. A.

Brickmaking Machinery.—Whose brickmaking machinery is most suitable for working up colliery spoil banks? A general description of the arrangement and some idea of the cost of a 20,000 per day plant would be very acceptable.—G.

Answer.—Seeing these past two weeks an inquiry from your correspondent "G," asking for a description and probable cost of machinery to prepare "Spoil bank clay" for making 20,000 bricks per day, I have made machinery for this very purpose in my own neighbourhood, and if the material is free from "rock," it will only require one pair of rolls fixed in strong housings over the cylinder or pug of a brick-making machine, with table to cut off twelve bricks at a time. I could deliver this machinery upon the rails here for £150, and it would require about a 12-horse engine to work it. If the material is mixed and there is rock with it, two pairs of rolls and strong housings will be necessary, the top rolls being fitted with knives for breaking the rock. This parcel of machinery will cost about £200 here. I can furnish full particulars if wanted.—Ixion.

[The name and address of "Ixion" can be had by "G." by writing to this office.—Ed. *P.E.*]

Steel Plates.—Will some reader kindly give me a list of lengths and widths of iron and steel plates kept in stock by most merchants. What I want is to be able to design tanks, boilers, &c., without having to get them cut, as this increases the labour, and does not add anything to the strength.—H.L.C.

Automatically Closing a Steam Valve.—Can any of your readers inform me of a method for automatically shutting, in a given short time, a steam valve that is opened by a movement which is too quick to be utilised for closing it, and where there is no other motive power available? I have heard that a wing valve would be suitable, but have no knowledge of such a valve, and should be obliged for a description of it, or any other method that would answer my purpose.—Piston.

Could any reader inform me how I am to make the following: I want some aluminium tubes about 1½in. diameter, $\frac{1}{16}$in. thick, and about 1½in. long, with flanges on the end. Can I buy the tubes ready made and solder the flanges on, or should I have to get sheet metal, and bend it over, and solder it up all along to make them? What would be the best kind of solder? Is aluminium very expensive, and who manufactures it?—W. Ll. P. W.

Marine Problems—Propeller Slip.—A certain propeller is removed and replaced by another of the same pitch, but with greater "slip." What effect will this have on the speed of the vessel, the engines working at their highest power in each case? The revolutions would apparently increase, owing to the load being lightened, but how would this affect the speed of the ship?—Q.

Illuminating Paint.—I should be glad to have the address of a maker of illuminating paint.—S. C.

Steel Castings.—Would any of your readers give me any information as to the theory of moulding and casting the above? Also if there is any work published on the subject?—Moulder.

Priming.—What are the chief causes of priming in marine boilers, and the remedy for same. I should like to be favoured with the construction of the hydrometer or salt guage.—Anti-Primer.

Ramsbottom Piston Rings.—Will some reader give me a little information on expanding Ramsbottom piston rings, steel and cast iron, for cylinders 12in., 16in., and 20in. diameter, varying from ⅜in. to ⅝in. wide, and ¼in. to ⅜in. thick.—A. J.

Electro-plating.—Could any reader kindly inform me how I best could re-electro.plate a tricycle? The cheapest and simplest style will oblige.—Club Tandem.

Stress on a Rope.—Will any reader assist me to calculate the stress on a steel rope 4in. circumference, working on an engine bank, dipping 1½in. in 12 inches. Load 14 tons.—Student.

Engineering Journal.—I shall be glad to know the nature of the contents of "Der Machinen Constructeur;" also how often it appears, the price, and where it is to be got?—Subscriber.

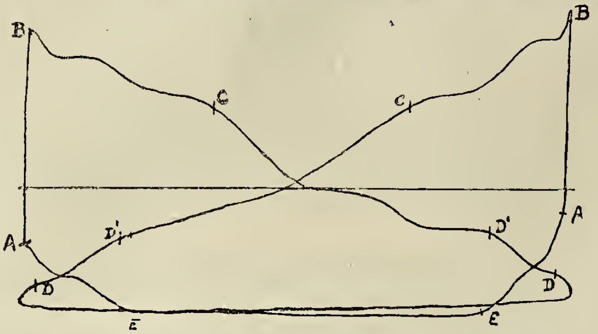
Turbines.—Will you or any of your readers kindly inform me what quantity of water per min. is required to drive a turbine of 6 i.h.p. with 6ft. to 9ft. of fall; also the diam. and speed of the turbine?—W. W.

Cost-keeping.—Can any of your numerous readers recommend me to a good practical cost clerk, who can teach a reliable system of cost-keeping, not merely a theoretical system, but a practical one, involving the least labour to arrive at results?—R. H.

Bright Work.—What is the best thing to put on bright work, after polishing, to keep coke oven sulphur off? I use tallow, but it gets through that the next day.—Engine.

TO CORRESPONDENTS.

A.W.—The subject is a very unsatisfactory one, or at least the formulæ relating to it are unsatisfactory, and cannot be relied on too implicitly. In "Mechanics of the Girder," by Grehore, published by Wiley and Sons, there is a chapter on pillars, which discusses all the best formulæ, and would help you if you could get to see a copy, Yorkshire —The wavy nature of the steam line on these diagrams makes it difficult to tell exactly where the points of cut-off and opening to exhaust really are. The ordinary indicator diagram, also, is not well adapted for showing where the actual opening to steam is made. In your case we should say that the parts are opened and fresh steam enters the cylinder at A, but usually the steam line of the diagram is considered to begin at B. The cut-off takes place about the points marked C, but the point of opening to the exhaust is a little more doubtful. It would seem as though there were a little opening at D¹, but the depressions here may only be due to the continuation of the wavy steam line: there is, however, no doubt about the exhaust being opened at D and closed at E.



J. Beaumont, Gomersal.—Will you please forward again particulars of engine from which diagrams were taken? The previous ones have been lost by the engraver.

Young Engineer.—Something is said on this subject in almost any work on the steam engine. "Richards' Steam Engine Indicator," by C. T. Porter (Longmans), will perhaps meet your requirements as well as any publication.

A. M. M. A.—We do not know of any special book on the subject, but there are several descriptions in the leading engineering papers of the past few years.

T. G. W.—In testing the power of an engine by the simple means described by you, care must be taken that all the power is really taken up in lifting the weight. The most convenient way is by the ordinary approved brake, in which the weight suspended from the circumference of the pulley, multiplied into speed of the circumference in feet per minute, gives the work done per minute.

D. H. P. —We do not see your difficulty; perhaps you will explain what you want more fully.

T. C.—See Official Journal of the Patent Office, January 14th, price 4d by post 5d.; sold at 38, Cursitor Street, Chancery Lane, E.C.

Boiler.—The shell $\frac{1}{16}$in. thick should be good for 50lb. pressure if well made, and with riveted joint; if the joint is brazed, we should say not more than 40lb. The shell $\frac{1}{8}$in. thick is twice as strong. You say nothing about the flue tube; if there is one, this might be much weaker than the shell.

W. W., Glasgow.—See the article on Belts and Pulleys in *The Practical Engineer*, February 24th, which will give you the power that may be driven by a belt. You can put on the smallest belt that will do the work of your tenant, and then reckon the horse power from the table in the article referred to.

Hope.—We have not seen the paragraph, and can only refer you to the Secretary of State for India.

MISCELLANEA.

Engineering Society, King's College, London.—At a general meeting, held on Tuesday, March 6th, the president in the chair, Mr. Frere read a paper on "Bridge Foundations." The author commenced by describing the methods for laying foundations in shallow water by means of earthen and coffer dams. Laying foundations by means of caissons was then gone into. This consists in building up the foundation's courses on a caisson, floating it to the required position, and slowly sinking it to the bottom of the river on to a bed of concrete; the sides of the caisson are then removed. In iron tubular foundations hollow cast-iron cylinders are sunk down by their own weight, while the soft soil inside is dug out, until a firm bottom is reached; it is then filled up with concrete and brickwork. The tops of the cylinders are generally closed, and air pumped in to drive out the water at the bottom. The author then described the screw pile, and the method known as the "pierre perdue." Particulars were then given of the foundations of the St. Louis Bridge (over the Mississippi), the Charing Cross Bridge, and the Tay Bridge.

Dundee Mechanical Society.—At the ordinary meeting of the Dundee Mechanical Society, held in the Y.M.C.A. rooms, on the 8th inst., a paper was read by Mr. John R. Stewart on "Milling Tools." These machines would probably soon supersede the shaping and slotting machine at present in general use, as they did the work more perfectly, and also quicker and cheaper. The periphery speed of the cutter was from 60 to 80 feet per minute, finishing the work at the rate of one inch per minute. The advantages claimed were exact duplication of work, rapidity of production (the cutting being continuous), cost of production, and cost of tools for producing a certain amount of work. Special attention was called to the comparative qualities of cutters, and reference made to those designed by amateurs and those by professional makers. The unsatisfactory work of the former, it was contended, retarded the introduction of this class of machine tool into Dundee. Milling tools were first invented 100 years ago, by Joseph Bramah, of hydraulic press fame. By the aid of a full-sized diagram of Smith and Coventry's universal milling machine, the technicalities of this tool were lucidly explained. A hearty vote of thanks was accorded to the lecturer at the close, and also to Messrs. Smith and Coventry, Manchester, for representative samples of the different classes of milled work kindly sent for the occasion.

SELECTED PATENTS.

APPLICATIONS FOR LETTERS PATENT.

March 2nd.

3181 Wire Door Spring Fittings, E. Hargreaves, Manchester.
3183 Air Compressor, D. A. Stanley, London.
3186 Gas Engine, C. Maltby-Newton, Croydon.
3187 Chain Cable, W. Rose, Birmingham.
3195 Protection of Door Places for Hoists, H. Emmett, Dukinfield.
3201 Producing Patterns upon Metal, Wood, &c., W. Orr and P. S. Brown, Glasgow.
3203 Forging and Resharpening Chisels, J. Jones, Manchester.
3211 Double-acting Pumps, H. A. Skinner, London.
3215 Incandescent Lamps, J. W. Oldroyd, London.—[Complete Specification.]
3216 Fuel Economisers, J. W. Oldroyd, London.—[Complete Specification.]
3222 Machinery for Making Cut Nails, J. I. Parkes and W. McWatt, Smethwick.
3223 Secondary Batteries, W. Kingsland, Gunnersbury.
3226 Gauges for Bloom Shearing Machines, C. Davy, London.
3227 Locks and Bolts, F. Smith and C. G. Smith, Birmingham.
3230 Electrical Tramways, F. C. Allsop, Bexley.
3233 Type-writing Machines, F. Myers, Liverpool.
3248 Band Tighteners, C. W. Jones, Ottawa, Canada.—[Complete Specification.]

March 3rd.

3261 Screens for Threshing Machines, W. Woollason, Lincoln.
3267 Lubricators, C. Billington and J. Newton, Longport.
3271 Stuffing Boxes, W. Davies and W. Fraser, Liverpool.
3282 Controlling Pressure of Water in Mains, H. Buckton, Halifax.
3286 Electrical Measuring Instruments, G. L. Addenbrooke, London.
3287 Lubricator, G. Fairclough, Manchester.—[Complete Specification.]
3299 Composition for Lubricating, W. P. Kelly, London.
3303 Registering Consumption of Electric Energy, H. H. Leigh, Chancery Lane. (Jean Louis Clerc, Paris.)
3314 Riveting the Joints of Tanks, &c., W. Skaife, London.
3320 Nut Lock, L. Surprenant, London.—[Complete Specification.]
3326 Screw Cutting Lathes, J. Breeden and F. Breeden, Middlesex.
3328 Commutators, C. Langdon-Davies, London.

March 5th.

3347 Water-Gauges for Steam Boilers, S. Matthews, Newcastle-on-Tyne.—[Complete Specification.]
3353 Paddle Wheels, W. H. Fry and T. Fry, Tynemouth.
3367 Driving Centrifugal Machines, W. L. Wise, London. (Burmeister and Wains Maskin-og-Skibsbyggeri, Denmark.)
3373 Dry Gas Meters, W. J. Warner, Westminster.
3381 Axle Boxes, H. Rogers, London.—[Complete Specification.]
3383 Gun Carriages, O. Krell, London.

March 6th.

3391 Ratchet Drills, J. H. Vinton, London.—[Complete Specification.[
3410 Treatment of Iron or Steel, J. F. Hall, Sheffield.
3425 Crushing Mills, G. Frisbee, Liverpool.—[Complete Specification.]
3427 Gas-motor Engines, G. McGhee and P. Burt, Glasgow.
3429 Corrugated Furnaces, J. G. Lawrie, Glasgow.
3439 Punching and Eyeletting Machines, M. H. Pearson, C. Bennion, and J. A. Keay, Leeds.
3449 Railway Switches, P. M. Justice, Middlesex. (R. H. Isbell, United States).—[Complete Specification.]
3450 Controlling the Action of Pumps, E. Paull, Liverpool.
3451 Thawing or Removing Snow or Ice, J. J. Lundy and F. G. C. Lundy, London.
3452 Generating Steam, A. Catchpole, London.—[Complete Specification.]
3454 Condensers for Steam Engines, J. Murrie, London.
3456 Electric Bells, W. H. Winnall, London.
3464 Split Pulleys, H. J. Haddon, London. (J. S. Zerbe, United States.)
3466 Lubricator, J. Y. Johnson, Middlesex. (La Société Million Guiet et Cie., France.)
3469 Stop Watches, H. A. Lugrin, London.—[Complete Specification.]
3473 Over-head Travelling Cranes, C. Wawn, London.
3477 Flexible Metallic Tubing, F. Walton, London.

March 7th.

3489 Electrical Switches, F. T. Schmidt, Bradford.—[Complete Specification.]
3485 Traction Engine Wheels, J. J. Arnold, Southampton.
3487 Waste Preventing Valves, G. Mitchell, Sheffield.
3495 Manufacture of Gas, A. McDougall, Manchester.
3496 Sheaves for Blocks, A. Higginson, Liverpool.
3498 Dynamo-electric Machines, T. Parker, Manchester.
3504 Multiple Electric Communication, J. Oldfield, London.
3513 Grinding or Cutting Stone, W. Rigby, Liverpool.
3516 Ventilators, Charles Brothers, London.
3518 Direct-acting Pumping Engines, J. Murrie, Glasgow.
3544 Cutting Screw Threads on Bolts, M. Bischoff, London.
3545 Sand Washing Machine, G. H. Greenway, London.
3546 Gas Engines, A. Rollason and J. H. Hamilton, London.—[Complete Specification.]

March 8th.

3553 Automatic Sprinklers, J. R. Ward, Manchester.
3556 Consuming Smoke, J. Taylor, Nottingham.
3558 Shaft Guard, S. Shaw, Manchester.
3561 Smoke-consuming Apparatus, G. B. Sharples, Manchester.
3565 Safety Plugs for Steam Generators, H. Hil er, Manchester
3570 Hydro-Extractors, J. R. Philip, Glasgow.
3578 Nut Locks, W. P. Thompson, Liverpool. (Max Albert, Prussia.)
3581 Water Gauges for Steam Boilers, W. Fraser, Liverpool.
3597 Centrifugal Pumps, W. Britain, Middlesex.
3608 Ball Valves and Stop Taps, H. J. Burgess, Brighton.

NOTICE TO NEWSAGENTS AND SUBSCRIBERS.

Numerous complaints having been made to us by Subscribers of the difficulty they experience in obtaining copies of the *Practical Engineer* in certain districts, we have to state that the Journal can be obtained by any Newsagent through the ordinary trade channels, and no difficulty should therefore exist in obtaining copies by order of any Newsagent.

For the information of the trade, we may state that copies can be obtained from either of our Offices in London or Manchester, or from any of the following wholesale houses, who are also supplied with Contents Bills for the use of the trade:—

W. H. SMITH & SON, Strand, London.
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R. SIMPSON, 38, Wilson Street, Middlesbro'-on-Tees.
GEORGE BROMBY, 26, Charles Street, Hull.
EDWARD KING, 37, Greyfriars Lane, Coventry.
&c., &c., &c.

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EDITORIAL NOTICES.

All communications for the Editor of this Journal should be addressed to 6, Victoria Station Approach, Manchester.

Communications intended for insertion in the current week's issue should reach us not later than Tuesday Evening.

We cannot undertake to return rejected manuscripts or drawings unless accompanied by a stamped and directed envelope.

Contributors are requested to write on one side only of the paper. Sketches should be sent on separate sheets.

TO ADVERTISERS.

Advertisements intended for insertion in the current issue should reach us on Wednesday morning at the latest.

Important Notice to Newsagents and Subscribers.

Our Publishing Offices in London are now at 11, PATERNOSTER BUILDINGS, E.C., where the Trade will in future be supplied.

Simultaneously with the above change, our PUBLISHING OFFICES in MANCHESTER have been REMOVED from Grosvenor Chambers, Deansgate, to more commodious and convenient premises at 6, VICTORIA STATION APPROACH, where all communications intended for the Manager or Editor should, in future, be addressed.

THE
PRACTICAL ENGINEER.
MARCH 23RD, 1888.

ON VARIOUS TYPES OF ENGINES.—II.

Of vertical direct acting engines, the marine engine with inverted cylinder is the best type, and is in fact the only form suitable for vertical engines of large size. The crank shaft and the oscillating parts being placed nearest the foundation, and the centre line of the framing being identical with that of the piston-rod, this engine combines the advantages of the best form of horizontal engine with those arising from the vertical position of the cylinder. These may be enumerated as freedom from vibration and springing, diminished piston friction and lubrication, more even wear of cylinder, and less liability to leakage at piston and gland.

The inverted cylinder engine may be run at a very high speed, and its strength of form is well proved from the rough work it has to go through, the sudden variations of load—ranging from full load to nothing—when the engines of a steamship are under full steam against a head sea, being a very severe and sufficient test, while its performance in the way of economy is unsurpassed. There is matter for surprise, considering the position it has attained in the marine engineering world, that this type of engine has not been more fully appreciated on land. It has, to a certain extent, been made a specialty by a few firms—Messrs. Hick, Hargreaves, and Co., of Bolton, among others; and we have no doubt that many visitors to the recent Manchester Exhibition would notice with pleasure the beautiful pair of engines in the electric lighting department, shown by Messrs. Mather and Platt, of Salford. The principal drawback to the engine appears to be that it requires balancing. This can be done by a weight opposite to the crank, or by having a pair of cylinders with cranks at opposite centres. The latter arrangement is not calculated to give the most regular turning without a fly-wheel of extra weight, but the latest improvement or development is to have three cylinders, with the cranks at equi-angles apart, an arrangement that appears to be all that can be desired where high speed and regular turning are essentials. The weight of the working parts of the engine is borne by the crank pin. This renders a slightly larger pin desirable, but the additional weight is small compared with the pressure from the steam on the piston, and the crosshead slide is relieved to the extent of the weight added on the crank pin.

A few words may be said as to compound engines. It is now generally understood that the gain from compounding is not due to any greater ratio of expansion being attainable as the same ratio may be attained in a single cylinder with sufficiently early cut-off. Practically, however, under ordinary conditions, a considerable gain has been found to accrue from the use of two or more cylinders, owing (according to one theory, which, however, has not been proved) to the range of temperature from admission to final exhaust being broken, with the result that cylinder condensation is greatly reduced, and all devices in the way of jacketing or compounding are merely for the purpose of reducing loss from this source—a loss of which the quantity cannot be calculated from diagrams, and can only be ascertained by actually weighing or measuring the water fed into the boiler, and by deducting therefrom the weight of steam shown in the diagrams. Another advantage of compounding is that it tends to equalise the strains, and to give more regular turning. Even in a tandem engine, where both pistons are connected to one crank, the high initial pressure is admitted to the smaller cylinder only, and the number of expansions being divided between the two cylinders, the steam is carried further through the stroke, and the fluctuations in speed are correspondingly diminished. With two engines coupled there is a slight gain from having the cranks near opposite centres, but with the low pressure leading, so that the low-pressure cylinder is open to receive the steam immediately, it exhausts from the high-pressure cylinder. There is, however, a heavier strain thrown on the gearing than is the case where the high-pressure crank leads, as was so ably shown by Mr. Longridge, of the Engine and Boiler Insurance Co., in his report for 1881. The placing of the cranks at or about opposite centres is also not so conducive to regularity of speed as placing them at right angles.

Another type of engine worthy of consideration, where water for condensing is scarce or not procurable, is the compound non-condensing engine, which can be worked with a consumption of fuel as low as the average of single-cylinder condensing engines.

THE STORM IN AMERICA.

Every day brings additional news of the fearful storm that overtook New York, Philadelphia, and the other towns and cities on the eastern seaboard of the United States at the beginning of last week. We hear of terrible reports of shipwreck, and of people frozen to death in the streets; of the absolute stoppage of business, and even of locomotion. The cemetery at New York was unapproachable, and 500 corpses accumulated unburied throughout the city. We hear of snow-ploughs being thrown from the tracks while trying to force a way through the snow-drift, and of steam pipes bursting, and scalding men to death, caused by the derailment of locomotives, and a thousand and one other disasters which are appalling in their nature and magnitude. The damage to property is estimated at £4,000,000. We have hitherto associated such wonders as this with the Wild West only, but for the first time in human memory the "blizzard" has overstepped the boundary line and attacked the eastern cities. The severity of the weather may be judged from the fact that nearly a week after the first appearance of the storm the snow in Broadway lay from 6ft. to 10ft. deep. The "blizzard" seems now to have established its claim to rank with fire, famine, and pestilence—as one of the great visitations to which society is liable; it has demoralised the entire working of an enormous area, and practically cut it off, for a time at least, from the outside world, and the only thing man can feel proud about is that, while acknowledging his defeat for the time, he can point with some pride to the recuperative power he possesses. In a fortnight New York will be continuing its course as though nothing had happened, and the inhabitants will look back on the "blizzard" merely as a curious occurrence, and for all practical purposes it will rapidly be obliterated from memory.

NOTES.

Some of the American journals seem to be concerned very much about the proposal to admit advertisements in the Brooklyn Bridge cars, which to many minds and eyes would be very offensive. The *Engineering News* says the great objection to the odious innovation is to be found in the fact that it is the eyes of the public and not so much the space that is being sold. "In other words, it is selling as one's own goods which have been merely delivered on consignment, which is an act of dishonest appropriation precisely analogous to that of a washerwoman who rents out the clothes entrusted to her for other use, while she is supposed to be merely washing them. To suggest that two great cities should go into this kind of business is repulsive to every right-feeling person, especially as the revenue gained is a mere bagatelle; $5,000 per annum being only *one cent* a year each for the 500,000 different individuals who patronise the bridge. Who would sell his own eyes to read advertisements for fifteen minutes a day for a cent a year? But what the individual would not do for himself the trustees have resolved to compel him to do whether or no." We should hardly have expected such strenuous opposition as the above indicates, as we thought innovation of any kind is looked upon in the States as a matter of course, and a thing to be taken without any grumbling. The English omnibus and tramcar proprietors do not appear to have much compunction in doing exactly what is proposed to be done by the trustees of the Brooklyn Bridge.

The Government have decided to take no steps with reference to the Paris Exhibition next year, and hence it is all the more necessary for zeal and energy to be shown on the part of private persons. The meeting at the Mansion House last week will, we trust, be followed by others in our large manufacturing towns, and it is to be hoped that the liberality of private gentlemen will make up for the neglect of the Government, so as to enable our exhibitors to make a respectable show. The United States have put £40,000 at the disposal of exhibitors, and have agreed to send American goods free.

The launch of the twin screw passenger steamer City of New York, in course of construction for the Inman and International Steamship Company, last week, was an event of great interest on the Clyde. These vessels are the largest ever built on the Clyde, and indeed are the largest passenger steamers in the world, their tonnage being 10,500 tons. The launch was perfectly successful, the vessel slipping into the river without perceptible list or quiver. The sister ship, City of Paris, will be launched about August.

The proposed bill for the renewal of the coal duties in London may still have a great chance of passing, inasmuch as, with few exceptions, members are not interested in the trade of London. They will, it is thought, be moved by the view that the abolition of duty means increase of rates, and some are not unwilling to keep up the price of fuel as the best way of purifying the London atmosphere.

LITERATURE.

The Engineer's Catechism. By Geo. L. Fowler; pp. 183; price 2s. 1d. New York: American Railway Publishing Company.

This handy little book has for its object the furnishing of information not usually found in the ordinary text-books, and is intended principally for the help and guidance of engine attendants and stokers, and hence does not profess to give instruction in the design and proportioning of steam engines. Our literature is really very bald in this particular department, and any publication that tends to remove this want will be heartily welcomed by working engineers. The catechism style of conveying information is one that, we must confess, we are not altogether enamoured of, as it seems somewhat clumsy, and leads to much redundancy, but there is no doubt that it enables many little bits of practical information to be dragged in by means of a suitable question that would not admit of proper classification, and hence might be overlooked in the ordinary style of writing. The author has been very painstaking over his work, and the answers he gives to the questions propounded are very practical, and just such as an engineer or stoker will appreciate. To give an example of the kind of question and answer given, we take the following from page 85: "Q. How long should be taken to raise steam? A. When the water and boiler are both cold—that is, of the temperature of the atmosphere—at least an hour and three-quarters or two hours should be allowed for a boiler 5ft. diameter and 16ft. long. For a larger boiler more time and for a smaller less time will be required. Further, when the water is warm or hot from simply standing over night, the time may be shortened proportionately; still, the longer the better." Many of the answers apply more particularly to boilers of smaller dimensions than are usual in this country, but sufficient can usually be gathered from them to utilise the information for boilers of larger size. Sketches are given of the various types of boilers, but some of these are crude and out of proportion. The vertical boiler, for example, measures 3ft. diameter and 8ft. high, the firebox for which is only represented as 2ft. high. We also notice that the ends of the egg-ended boiler are shown made up of six plates, coming to a point at the centre without any centre piece. These, however, are minor matters, and do not influence the value of the information given. The heads under which the various questions are classified are: Requirements of an engineer; boiler; boiler-houses; fittings; firing; feeding; cleaning; emergencies; the engine; erection; emergencies. The remarks on setting of valves are very good. A brief index is given at the end of the book, but we think it would have been more useful if made more extensive.

Mathematical Instruments. By J. F. Heather, M.A.; 14th edition; pp. 216; price 1s. 6d. London: Crosby, Lockwood, and Co.

That this work should have passed through thirteen editions is a sufficient tribute to its worth without any commendation from us. The work first came out in 1849, and has been more or less continuously used in the Government military and naval schools. In 1871 an enlarged edition was produced, but the continued demand for the original volume has necessitated the publishing of a fourteenth edition, which has been improved and brought up to date by the addition of descriptions of several new instruments, which will add to its utility. The book treats of all the common instruments used for drawing, as well as optical, surveying, and astronomical instruments.

TRANSMISSION OF POWER.—VI.

WIRE ROPES.

For teledynamic transmission—that is to say, for transmission of power to long distances—wire ropes have been used ever since they began to be manufactured as substitutes for hemp ropes, now some forty years ago. They have been used for conveyance of power from water-wheels to distances of several miles, for connection of underground machinery in coal mines, with engines situate at the surface, both for hauling and pumping, and for direct haulage purposes generally; but with the latter we do not propose to deal.

M. Leloutre, in an article from which we have previously quoted somewhat extensively, considers that the loss through friction and other dead resistances can be brought down as low as thirty, or even twenty, per cent in transmitting power by ropes through distances of six or seven miles and upwards; and that, while electric transmission may be employed in connection with great mountain waterfalls, water power nearer at hand may be utilised advantageously through ropes.

The heavy outlay in each case is the same, being that incurred in constructing the necessary head races and tail races, and in erecting the hydraulic motors.

The co-efficient of friction for an iron wire rope in a round-bottomed pulley groove that is lined with leather standing on end is found by experiments to be 0·220 for a half turn round the pulley.

Experiments have been made at a spinning mill at Oberursel, in Nassau, to which water power is transmitted through iron wire ropes, from a distance of 3,150 feet, in eight spans of about 394 feet from pulley to pulley.

When using the maximum quantity of water, equal to 175 h.p., the useful effect was only 99 h.p., tested by friction brake at the mill, or 56 per cent.

The aggregate loss of power by friction of pulley bearings, stiffness of ropes, and resistance of air, ranged from 11½ to 12 h.p. for seven of the spans taken together. The ropes were ·59 inch in diameter, and travelled at about 55 to 60 miles per hour; the pulleys were 14·8 feet in diameter, and the weight of each was about 28cwt.

M. Leloutre, from these experiments, considers the co-efficient of friction for the pulley bearings to be ·090; co-efficient of stiffness of the iron wire ropes to be ·092; and the co-efficient of air resistance of the arms of the pulleys to be ·000451.

The reduction of power from 175 h.p. to 99 h.p. appears to include the loss due to the hydraulic motor, but no particulars of this are given.

PATENT LAW AND MECHANICAL STOKERS.

At a meeting of the Oldham Chamber of Commerce, on Monday evening, the present anomalous and unsatisfactory state of the patent laws was introduced by Mr. Hesketh Booth, solicitor, who is acting for one of the persons recently sued by Mr. Proctor, in consequence of the recent decision of the Court of Appeal, which has confirmed the verdict of the court below, that Proctor's patent had been infringed by Bennis.

Mr. Booth said they were all aware that there had been a considerable amount of litigation in regard to mechanical stokers. An action had been brought against a large number of persons, including several Oldham and Bolton firms, by Mr. Proctor, the patentee of a mechanical stoker. Amongst the persons sued by Proctor were Messrs. Cross and Winksworth and Messrs. Greenhalgh and Shaw, of Bolton, and Messrs. Kirkham and Mannock, of Oldham. The costs of Messrs. Cross and Winksworth in prosecuting their defence amounted to a very considerable sum, and they considered themselves unfairly treated, and so did the Oldham firms. What they complained of was that users should be placed in this position: Proctor was a patentee; so was Bennis. They were in open competition for the trade, and both exhibited their stokers at the Smoke Prevention Exhibition at Manchester, in 1882, and also at the Oldham Exhibition the year after, and no complaint was made by either patentee of the infringement of the other's patent. The users, under these circumstances, thought it very unfair, now that it had been established that Proctor's patent had been infringed by Bennis, that Proctor should be at liberty to sue for damages the innocent users who had purchased from Bennis. They thought it very unjust to have actions of that kind brought against them.

The Bolton Chamber of Commerce had adopted a memorial in reference to the subject, and sent it to the Board of Trade. Messrs. Cross and Winksworth and Messrs. Greenhalgh and Shaw had also memorialised the Board of Trade on the subject, and he believed the Manchester Chamber of Commerce had been moved to do so. He could further say that a leading member of the firm of Messrs. Cross and Winksworth had had interviews with the President of the Board of Trade (Sir Michael Hicks-Beach) on the question, and he looked favourably on the object of the memorial. He had also had an interview with Lord Herschell, ex-Lord Chancellor, on the question, and he was somewhat in favour of the views expressed in the memorial from Bolton. He (Mr. Booth) had drawn up a short memorial, which that chamber might adopt that night. It was a question which should be dealt with very promptly, because there was a committee of the House of Commons now sitting on the question of amending the Patent Laws. It was desirable they should have the views of the Oldham Chamber, if they had any views on the question, and that they should have those views at once.

Mr. Booth then read the memorial he had drawn up, reciting the letters patent which had been granted to Edward Bennis, of Bolton, and James Proctor, of Burnley, and the actions which had been brought by James Proctor against Edward Bennis in 1886 and 1887, and a large number of other persons and firms who had bought and used Bennis's stoker. The memorialists believed that the recent decisions had led Proctor to make claims for damages upon hundreds of persons who had purchased mechanical stokers from Bennis openly and in competition with Proctor, and had induced other patentees to bring actions against innocent users who had acted in good faith in the purchase and adoption of patented inventions.

The memorialists submitted that some means should be devised for determining whether a proposed invention would or would not be an infringement of an existing patent before the proposed patentee should be granted letters patent or be at liberty to sell his patent.

Mr. Joseph Travis moved that the memorial be adopted, and that copies be printed and circulated amongst the members, and forwarded to the Board of Trade, the borough and county members, and to Lord Herschell. He thought that the public ought to be protected from such vexatious and costly litigation, and that those who claimed to be the inventors should contest their claims before a patent was granted. Some portions of our Patent Laws were barbarous, and appeared designed for levying black mail. They had not been revised for a very long time.

Mr. Edward Ingham, in seconding, said, considering the large amount of money the Government received from patents, he thought the onus and responsibility of determining the validity of every patent granted ought to be placed upon the Government or the authority granting such patent, and that when once granted both the owner and the user should be exempt from any further litigation in the possession and use of such patent.

The motion was unanimously adopted.

ECONOMY OF THE NON-CONDENSING ENGINE.

At the ordinary meeting of the Institute of Civil Engineers, on Tuesday, the 13th of March, the president, Mr. Bruce, being in the chair, the paper read was on "Economy Trials of a Non-Condensing Steam Engine—Simple, Compound, and Triple," by Mr. P. W. Willans, M.Inst.C.E.

The author described a series of economy trials, non-condensing, made with one of his "central-valve" triple-expansion engines, with one crank, having three cylinders in line. By removing one or both of the upper pistons the engine could be easily changed into a compound or into a simple engine at pleasure. Distinct groups of trials were thus carried out under conditions very favourable to a satisfactory comparison of results. No jackets were used, and no addition had, therefore, to be made to the figures given for feed-water consumption on that account. Most of the trials were conducted by the author, but check-trials were made by Mr. MacFarlane Gray, Professor Kennedy, Mr. Druitt Halpin, Professor Unwin, and Mr. Wilson Hartnell. The work theoretically due from a given quantity of steam at given pressure, exhausting into the atmosphere, was first considered. By a formula deduced from a diagram of Mr. MacFarlane Gray, which agreed in results with the less simple formulas of Rankin and Clausius, the lbs. weight of steam of various pressures required theoretically per indicated H.P.-hour were ascertained. (See table below.) A description was then given of the main series of trials, all at 400 revolutions per minute, of the appliances used, and of the means taken to ensure accuracy. A few of the results were embodied in the following table. The missing quantity of feed-water at cut-off, which, in the simple trials, rose from 11·7 per cent at 40lb. absolute pressure to nearly 30 per cent at 110lb., and at 90lb. was 24·8 per cent, was at 90lb. only 5 per cent in the compound trials. In the latter, at 160lb., it increased to 17 per cent; but on repeating the trial with triple-expansion, it fell to 5·46 per cent, or to 4·43 per cent in another trial not included in the table. On the other hand, from the greater loss in passages, &c., the compound engine must always give a smaller diagram, considered with reference to the steam present at cut-off, than a simple engine, and a triple a smaller diagram than a compound engine. Nevertheless, even at 80lb. absolute pressure, the compound engine had considerable advantage, not only from lessened initial condensation, but from smaller loss from clearances, and from reducing both the amount of leakage and the loss resulting from it. These gains became more apparent with increasing wear. The greater surface in a compound engine had not the injurious effect sometimes attributed to it, and the author showed how much less the theoretical diagram was reduced, by the two small areas taken out of it, in a compound engine than by the single large area abstracted in a simple engine. The trials completely confirmed the view that the compound engine owed its superiority to reduced range of temperature. At the unavoidably restricted pressures of the triple trials, the losses due to the new set of passages, &c., almost neutralised the saving in initial condensation; but with increased pressure, say to 200lb. absolute, there would evidently be considerable economy. The figures of these trials showed that the loss of pressure due to passages was far greater with high than with low-pressure steam, and that pipes and passages should be proportioned with reference to the weight of steam passing and not for a particular velocity merely. The author described a series of calorimetric tests upon a large scale (usually with over two tons of water), the results of which were stated to be very consistent. After comparing the rates of initial condensation in cases where the density of steam, the area of exposed surface, and the range of temperature were all variables, with other cases (1) where the density was constant, and (2) where the surface was constant, the author concluded that, at 400 revolutions per minute, the amount of initial condensation depended chiefly on the range of temperature in the cylinder, and not upon the density of the steam or upon the extent of surface; and that its cause was probably the alternate heating and cooling of a small body of water retained in the cylinder. The effect of water, intentionally introduced into the air-cushion cylinder, corroborated the author's views, and he showed how small a quantity of water retained in the cylinder would account for the effects observed. At lower speeds surface might have more influence. The favourable economical effect of high rotative speed, *per se*, was very apparent. In a trial with a compound engine, with 130lb. absolute pressure, the missing quantity at cut-off rose from 11·7 per cent at 405 revolutions to 29·66 per cent at 130 revolutions, the consumption of feed-water increasing from 20·35lb. to 23·67lb. This saving of 14 per cent was due solely to increase of speed. Similar trials had been made with a simple engine. In one simple trial at slow speed the missing quantity rose to 44·5 per cent of the whole feed-water. The author compared a series of compound trials, at different powers, with 130lb. absolute pressure, and various ratios of expansion, with a series giving approximately the same powers at a constant ratio of expansion, but with varying pressures, being practically a trial of automatic expansion against throttling. Starting with 40 indicated H.P., 130lb. absolute pressure, four expansions, and a consumption of 20·75lb. of water, the plan of varying the expansion, as compared with throttling, showed a gain of about 7 per cent at 30 indicated H.P., but of a very small percentage when below half-power. If the engine had an ordinary slide-valve, the greater friction, added to irregular motion, would probably neutralise the saving, while if the engine were one in which initial condensation assumed more usual proportions, the gain would be probably on the side of variable pressure. Even as it was, the diagrams showed that the missing quantity became enormously large as the expansion increased. Judging only by the feed-water accounted for by the indicator, the automatic engine appeared greatly the

Intended mean admission-pressure ....lb.	40	90		110		130	150		160		170
Simple, Compound, or Triple	S.	S.	C.	S.	C.	C.	C.	T.	C.	T.	T.
Actual mean admission-pressure ....lb.	40·88	92·65	87·54	106·3	109·3	130 6	149·9	151·9	158·5	158·1	172·5
Percentage ratio of actual mean pressure, referred to L.-P. piston, to theoretical mean pressure....	98·2	100	91·3	100·7	94·8	94·2	94·6	84·54	95·9	85·3	85·2
Indicated Horse-Power....	16·51	31·61	29·14	33·5	33·0	36·31	38·59	35·69	39·55	35·56	38·45
Feed-water actually used per indicated H.P.-hour:											
Simple..........lb.	42·76	26·89	—	26·0	—	—	—	—	—	—	—
Compound...... ,,	—	—	24·16	—	21·37	20·35	19·45	—	19·19	—	—
Triple .... ,,	—	—	—	—	—	—	—	19·68	—	19·19	18·45
Steam required theroetically per indicated H.P.-hour..................lb.	34·67	19·24	19·86	17·9	17·65	16·25	15·23	15·16	14·87	14·9	14·36
Percentage efficiency	81·1	71·5	82·2	68·9	82·5	80·0	78·3	77·0	77·4	77·6	77·8
Percentage of Feed-water missing at cut-off in H.H.-P. cylinder	—	—	—	—	—	—	—	5·33	—	6·84	5·01
Ditto H.-P. cylinder	—	—	5·0	—	9·5	11·7	15·1	14·84	17·0	12·06	15·33
Ditto L.-P. cylinder	11·7	24·8	15·2	29·56	16·25	19·1	20·6	22·12	21·3	22·11	24·21
Percentage of Feed-water missing at end of stroke in L.-P. cylinder	10·4	18·83	14·25	21·53	16·59	17·55	20·69	18·01	19·55	18·81	19·25

more economical; but actual measurement of the feed-water disproved this. The position of the automatic engine was, however, relatively more favourable when simple than when compound. In conclusion, the author referred to a trial with a condensing engine, at 170lb. absolute pressure, in which the feed-water used was 15·1lb., a result evidently capable of further improvement, and to an efficiency trial of a combined central-valve engine and Siemens' dynamo, made for the Admiralty, at various powers. At the highest power the ratio of external electrical H.P. to indicate H.P. in the engine was 82·3 per cent. Taking the thermo-dynamic efficiency of the engine at 80 per cent, that of the combined apparatus would be nearly 66 per cent.

A GREAT INDIAN BRIDGE.

The bridge over the River Ganges at Benares, lately completed by the Oude and Rohilkund Railroad Company, forms a most important link between the railroads in Oude and the North-Western Provinces and the East Indian Railway. It brings Lucknow in direct railroad communication with Calcutta by a route 52 miles shorter than that *via* Cawnpore. The junction with the East Indian Railroad at Mogul Serai will give the nearest route to the Punjab *via* the Oude and Rohilkund Railroad Company's new Northern Extension joining in with the North-Western Railway at Saharunpore.

The bridge consists of 16 spans, viz., seven of 356ft. and nine of 114ft., measuring from centre to centre of piers. The larger spans extend from the north bank over the river, and the smaller spans are flood openings in case of overflow of the river on the south bank. The total length of the bridge from end to end of girders is 3,523ft. The piers of the larger spans are founded on elliptical wells 65ft. by 28ft. The piers of the smaller spans are each founded on two circular wells 12ft. 6in. in diameter, pitched 25ft. centre to centre, and varying in depth from 63ft. to 152ft. below ground level. Both abutments are founded without well foundations—that at the south end having long wing-walls giving access to the bridge by a flight of steps on each side. On these abutments block-houses will be constructed for the military defence of the bridge.

The weight of the material used in one of the deep piers is about 16,000 tons. This enormous weight has, with the exception of the iron caisson and stone cap, been carried into place on coolies' heads along a narrow floating staging leading to each pier.

The girders are lattice built, and are entirely of steel, the total weight of steel used in the 16 spans being 6,405 tons. They were supplied by the Patent Shaft and Axletree Company, Wednesbury, England. The main spans are the longest yet constructed in India, without the use of the cantilever form of girders, and the foundations of some of the main piers are the deepest in the world, being in some cases 140ft. below water level. The girders of the main span are 35ft. in depth and 25ft. apart, centre to centre. The traffic is carried between the girders of the main span and on the top of the girders of the smaller spans, the road and the rail being of the same level, with footways on either side on cantilevers outside the main girders. The girders of the smaller spans were utilised for erecting the main girders. Their length being one-third that of the main girders, it required three of the smaller girders to carry one of the larger, and therefore by erecting two temporary piers, one of the main openings was spanned by three smaller girders.

Work was carried on by day and night except during the very cold weather. The Gulcher system of electric lighting was in use, and worked most satisfactorily. It may be confidently stated, that without the assistance of electric light the bridge would not have been built, simply because it would be impossible without continuous night-work during the busy time to get through such work as must be completed to render the structure safe from flood during each season. The first brick of this bridge was laid January 19, 1882, and it was ready for traffic in October, 1887.—*Indian Engineering.*

VULCANISED WOOD PULP.*

In a paper read by me before this club some time ago, entitled "Wood Pulp and some of its Peculiarities," which related to the manufacture of seamless wood pulp barrels, I hinted at some experiments I was then engaged upon tending toward the vulcanisation of wood fibre, and which I have kept up until I accomplished the desired end (the missing link mentioned in that paper).

The results of those experiments were so remarkable that no one could be more astonished by them than myself. I began, of course, with considerable knowledge of the material and all its treatments, being familiar not only with my own processes from years of practical laboratory and factory work, but also with that in general use at the various manufactories of indurated fibre throughout the country.

One trouble with the indurated fibre ware, so called, is that it takes about six days to complete an article, such as a pail or wash-basin, and when completed it lacks the requisite strength, being strong only in the glaze or shell of exceeding thinness on the outside of the vessel, the inside being pulpy, and when the glaze wears off, this filling is moistened, and then the inside will swell, which of course destroys the utility of the article. Then the process is too costly, a large article like a barrel costing upwards of 12s.

My object was to obtain three distinct results:

First. A material impervious to moisture of any kind, all through its fibre, resisting not only water and oil, but also alkali and acids to a marked degree.

Second. A solid and strong article with a high tensile strain.

Third. To avoid the expense and waste of time required to complete an article by reducing the processes which it must pass through and expediting its completion as much as possible.

In the first place, I take spruce pulp (in sheets) as it comes from the mills, and beat it into pulp. Then I take pitch and treat it in an electric bath, which changes its nature entirely; then the pitch and pulp are mixed together in proportion of 1 to 20 and put in another beating engine, the water contained therein being also heavily charged with electricity. This product is then pressed into pails, wash-basins, &c., in moulds, and in the usual manner; then the vulcanising is done with a temperature of from 325° to 350° Fahr., or to a point sufficiently high to melt the mass. This gives me a product which maintains a uniform strength, colour, and density throughout, which average stensile strength of 9,000 per square inch of section; a result so remarkable as to be almost incredible. It is capable of taking a high polish, resembling guttapercha or hard rubber in a marked degree.

It is a good non-conductor of electricity (resisting 4,000,000 ohms), being almost as good as hard rubber for such purposes, and by a slight variation in the proportions and temperature of vulcanising it can be made exceedingly flexible and even pliable; but the strangest property of this material is found in its readiness to join with other pieces, precisely as two pieces of india-rubber are joined together.

By this process I can make articles in the forenoon from the raw pulp, and in the afternoon they will be completed and ready for shipment; in fact, a barrel can be made ready to be filled with petroleum (or its products) in ten to fifteen minutes, and at a cost of 1d. per lb.

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*Paper by Mark L. Deering, M.E., Member of the Civil Engineers' Club of Cleveland, read November 22, 1887.

A LARGE BRASS DRAWING.

One of the new elements of construction rendered necessary by the invention of the dynamite gun by Captain E. L. Zalinski, has been the need of a brass shell for the projectile. A firm in Waterbury, Conn., Brown and Brothers, have succeeded in making a shell of seamless drawn brass, with conical head, $\frac{3}{16}$in. in thickness, and weighing 200lb. Its length is 6ft. 8in., and inside diameter 14in., the whole being in one piece produced by the cold flow of the metal drawn into shape with the hydraulic ram. This shell is designed for the purpose of carrying 600lb. of explosive gelatine, and at Cramp shipyard, at Philadelphia, a special ironclad of very high speed is being built for the purpose of carrying this dynamite gun.—*Engineering.*

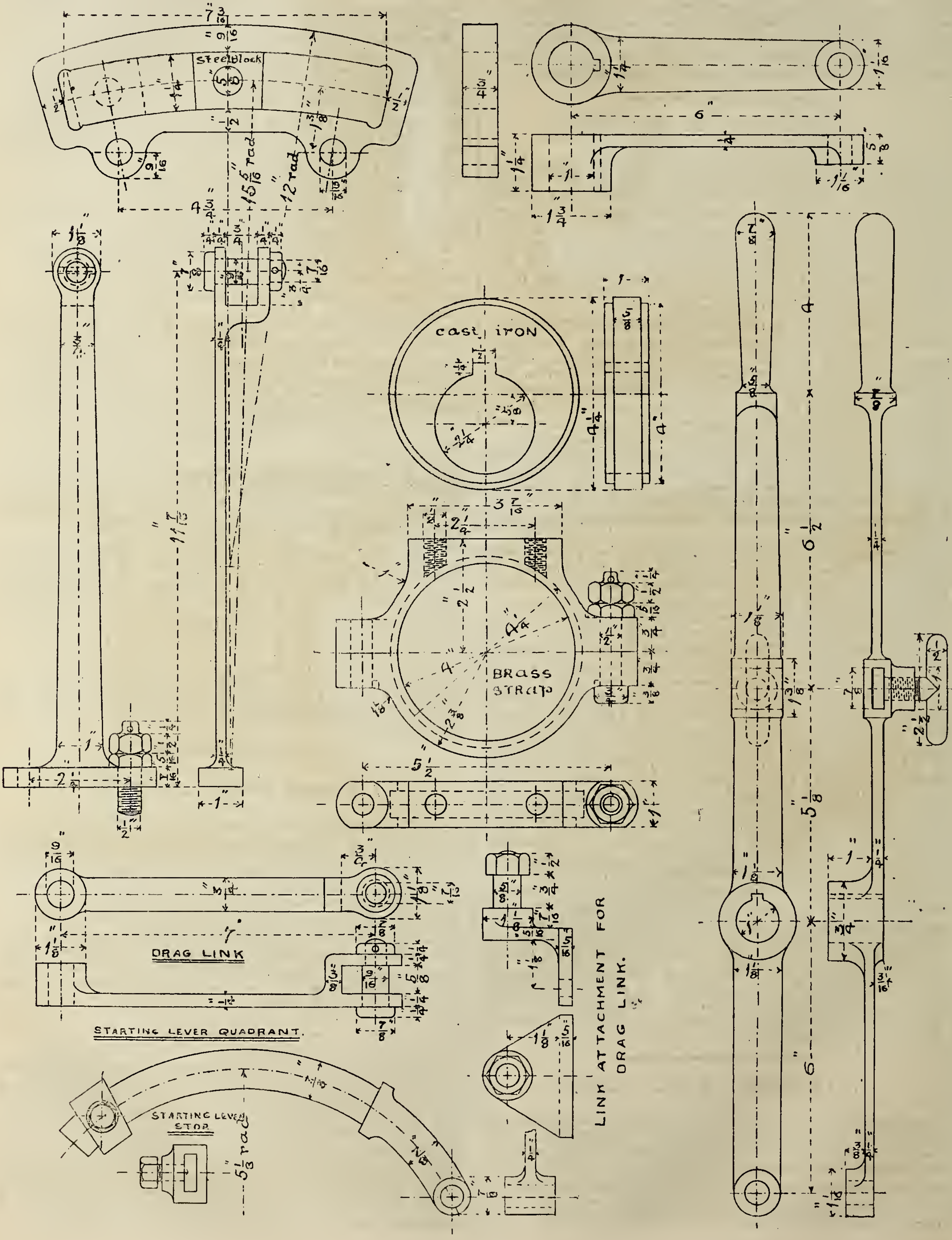
Cast-steel Gun.—The new cast-steel gun, recently cast at Pittsburg, Pa., has been bored out, and the prospects of the success of the gun are very bright. The man in charge of the boring reported that in twelve years' service he had never met with steel of such uniformity of grain. Had there been any flaw in the gun, it would probably have been detected by the drill. All the borings have been saved, and samples have been carefully examined. When the gun has been annealed it will be sent to Washington, where it will be rifled and tested. It is fully expected that all the tests will be stood without injury. The interior of the bore has been examined with the aid of the electric light.

WORKING DRAWINGS.

LAUNCH ENGINES.—III. Details of Link Motion, Starting Lever, &c.

NOTE.—ALL WROUGHT WORK TO BE OF MILD STEEL.

SCALE, 4in.=1ft.



MACHINES FOR PATTERN SHOPS.—II.

CIRCULAR SAWS.

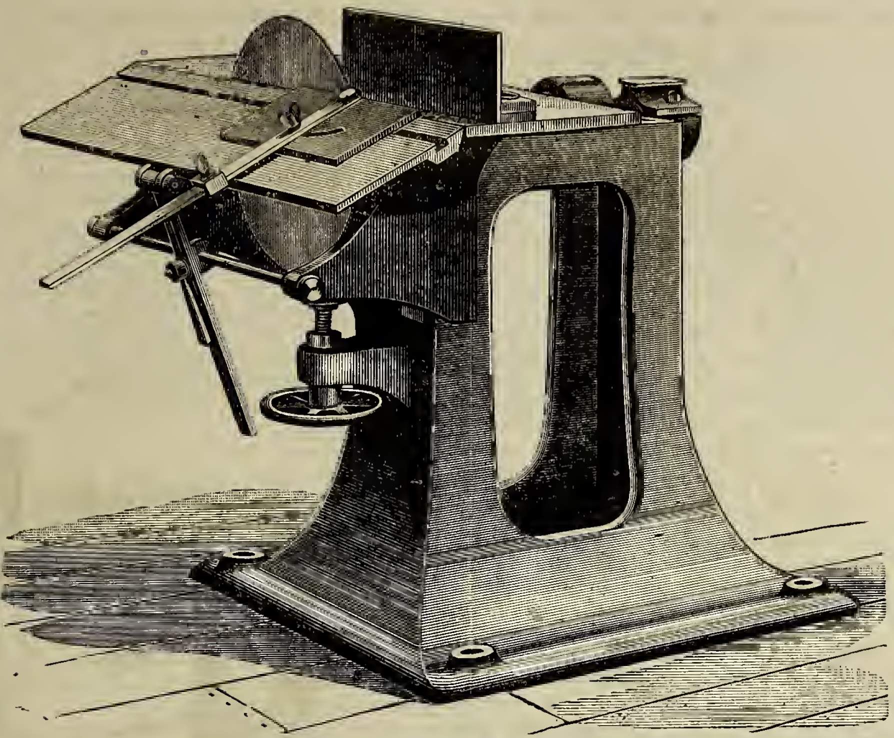
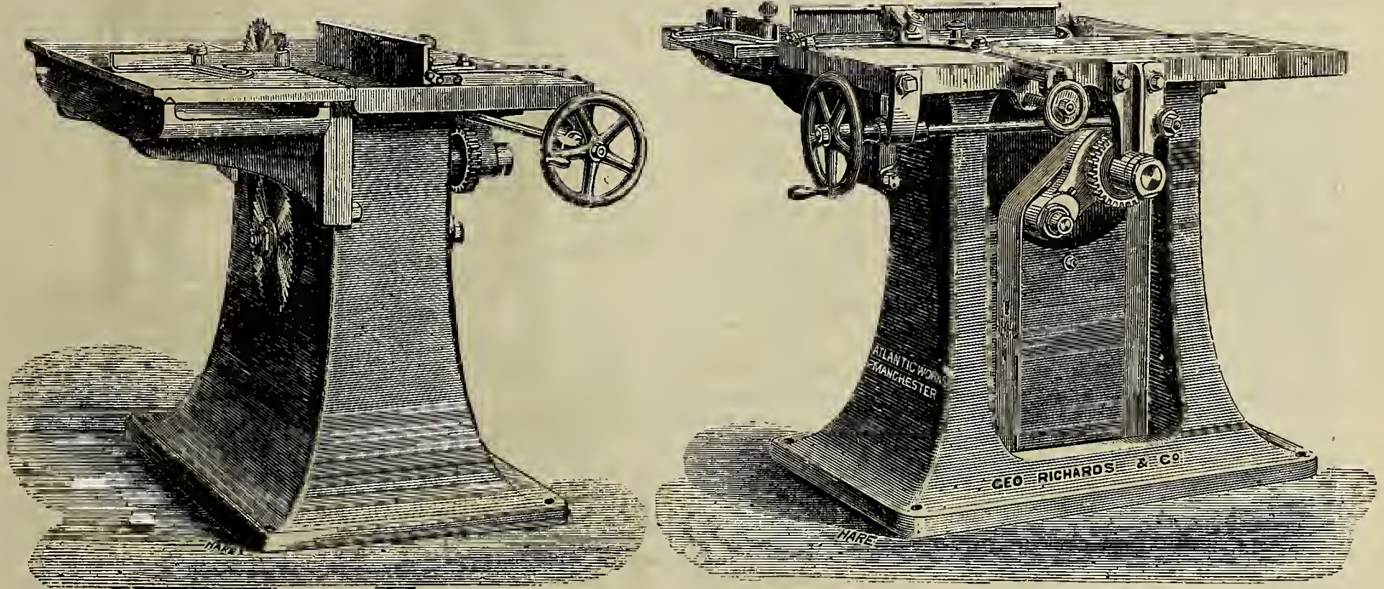


FIG. 5.—THOMAS ROBINSON & SONS, ROCHDALE.



Front View.

Back View.

FIG. 6.—GEORGE RICHARDS & CO., BROADHEATH.

THE machine saws, though not so absolutely indispensable as the lathes, are yet so essential, regarded from an economic point of view, that we must regard them as necessary portions of the equipment of any pattern shop of fair pretensions. There are very few shops indeed but have their circular and band saws. But there is a vast difference in the design and general utility of these machines, so that many old saws which, when introduced years ago, were the best available at the time, are now antiquated, slow, and unsatisfactory in action when compared with those of more modern manufacture. I think there is scarcely a branch of engineering in which greater advances have been made during the author's lifetime than that which embraces the manufacture of wood-working machines. I shall treat, therefore, only of those recent improved and modified forms of circular and band saws which commend themselves by reason of their combined efficiency and simplicity of design.

The cast-iron "boxed" framework is a matter of importance in circular saws, as tending to deaden vibration and furnish the utmost rigidity, with an economical employment and judiciou distribution of metal. Braced wooden framings, though cheap, are not properly suitable for circular saws doing regular shop work, though well enough adapted for amateur use, and they do not readily permit of the good attachment of fences for thicknessing, bevel sawing, &c.; at least not to anything like that afforded by a planed cast-iron table. And beyond this, for pattern-shop use even the circular saw should be of a somewhat special character. Properly there should be two saw benches in a shop of moderate size: one for plain cutting—a 16in. saw being as large as is usually required—and another provided with canting motions. Of the first I need say nothing except that it should be one of the ordinary type used by carpenters and joiners, and be employed for ripping material in quantity, and for the thicker and heavier planks and blocks. It should be provided with an adjustable fence, worked with a screw and hand-wheel, but not necessarily fitted for canting, and the spindle may be fixed—*i.e.*, not rising and falling. For the second, the choice may lie between a single saw, of which I have selected fig. 5 as a useful type, or a dimension saw, which type is well represented in fig. 6. The first, made by Messrs. Robinson, of Rochdale, is furnished with a rising and falling table, actuated by a hand-wheel and screw. This form of table is useful, because, by its capacity of adjustment for depth below the teeth of the saw, it enables *shoulders* to be cut, so saving a deal of laborious rebating by hand. Of this class of work there is very much done in pattern shops; boxed-up work, as a single example only, being mostly made with rebated joints. This rebating, when done by hand, is effected by tacking a straightedge along one edge of the intended rebate as a guide to the plane, and slow work it is. But with the fence shown, and the adjustable rising table, rebates—whether deep or shallow—can be sawn at once, almost or absolutely coincident with the gauged line, so that no finishing with the plane is required. A rising table is also largely used for grooving purposes, but very little of this is done in the pattern shop. This saw can also be employed for the plain ripping and cross-cutting of the smaller pieces of wood, such as ribs, brackets, flanges, &c., which enter so largely into all pattern construction. So much bevelled cutting also has to be done in our trade, that the absence of a circular saw having special provision for this is a great mistake. Such provision is better made on a small bench of this character than on one of larger size, because it is mostly on the smaller stuff that bevelling requires to be done. In the figure it is seen that the front part of the table is made to cant, adjustment being made with the slit bar seen toward the left-hand end. For cross-cutting, either square or to a bevel, the angle slide bar and plate are fitted to the canting table (as seen), the timber being thus set and maintained at the proper angle for sawing, without trouble on the part of the attendant workman.

In Mr. Richards' machine (fig. 6), the *movable* saws take the place of the adjustable table in the previous illustration. The advantage of combining two saws in one machine is this: Sawing of two distinct kinds can be done thereon, one being spaced, set, and sharpened for ripping or cutting lengthwise of the stuff, the other for cross-cutting only. Each saw is adapted therefore for its own proper set of operations, as indeed it ought to be; whereas when one saw only is employed, it is spaced, set, and sharpened on the basis of a compromise or mean between what it ought to be for either one of the operations named. Ripping and cross-cutting saws can, however, be substituted for one another on their spindles in ordinary machines, but as this occupies time it is only done when there is a sufficient amount of the same kind of work to make the alteration worth effecting.

The mechanism by which the rising and falling spindles are actuated is simple and perfectly efficient, consisting of a worm and wheel, which revolves the frame carrying the saws, bringing either one to the top at pleasure, and also adjusting the precise height of the same above the table when required for cutting shoulders. The driving belt is held in tension in any position by means of a counter-balanced pulley below, which, though revolving on a movable centre to suit the varying heights of the saw spindles, is always held against the belt by the counterbalance-weight. This is a decided improvement on some of the older dimension saws, in which a hinder pulley and counterbalance, together with the driving pulley, are placed without the saw and in line with it, leaving the belt exposed. Here the whole is contained within and below the framing.

Ripping, both square and bevel, is performed against the carefully-adjusted fence, which is actuated with a hand-wheel and screw. The sliding table at the front, and the adjustable gauge thereon, capable of being swivelled to any angle, and furnished with an index, allows of cross-cutting being performed with extreme accuracy and exact uniformity where a number of pieces are concerned. The dimension saws are of the usual size, viz., 12in. in diameter. By removing both, a single large saw, 18in. in diameter, for heavy sawing, can be substituted at pleasure.

For those shops where engine-power is not available, a plain saw driven by the foot soon pays for itself. For a good and cheap circular of this kind, I know of none better suited to the purposes of the pattern-maker than that shown in fig. 7, which has been patented by the Britannia Company, of Colchester. Having seen this saw at work, I can testify to its efficiency. There is no slip, as there is in some of the belt-driven saws—there can be none, in fact, except by the gear-wheel teeth breaking out. The idea of using cogwheels with the view of imparting *positive* motion is certainly a good one. The necessary cutting speed (1,500 revolutions per minute) is obtained by gearing *down*, and the irregularities of the treadle are corrected, and momentum obtained by a heavy flywheel on a second shaft. The momentum is sufficient, after the speed is got up, to cause the saw to cut 4ft. 3in. of dry inch stuff after the foot is removed from the treadle. 10ft. of inch stuff can be sawn per minute. Stuff as thick as 4in. can be sawn. Both square and bevel cutting can be done against the canting fence seen in the figure. Saws can be changed for ripping, cross-cutting, or grooving. The table is made to rise by hand-wheel and screw (seen underneath), so that both grooving and rebating can be easily done. The little attachment to the right, for boring holes, is useful on repetition work of this kind. Where no power is available, this saw is all that can be desired.

The fences for any circular saw designed for pattern-shop use should be constructed with much care, and always with a view to *bevel* sawing. Those whose fences are only roughly fitted, and which do not provide for precise adjustment both for thickness and angle, are not economically suitable for our work. It is often necessary to saw stuff with minute quantities of taper, extending to a few degrees only, as well as to cut long bevels. It is laborious work to produce these by the hatchet, draw knife, planes, or hand-saw, or by rigging up some clumsy piece of wood blocking on the table of the saw, when a good fence would provide an accurate and ready means of gauging any angle.

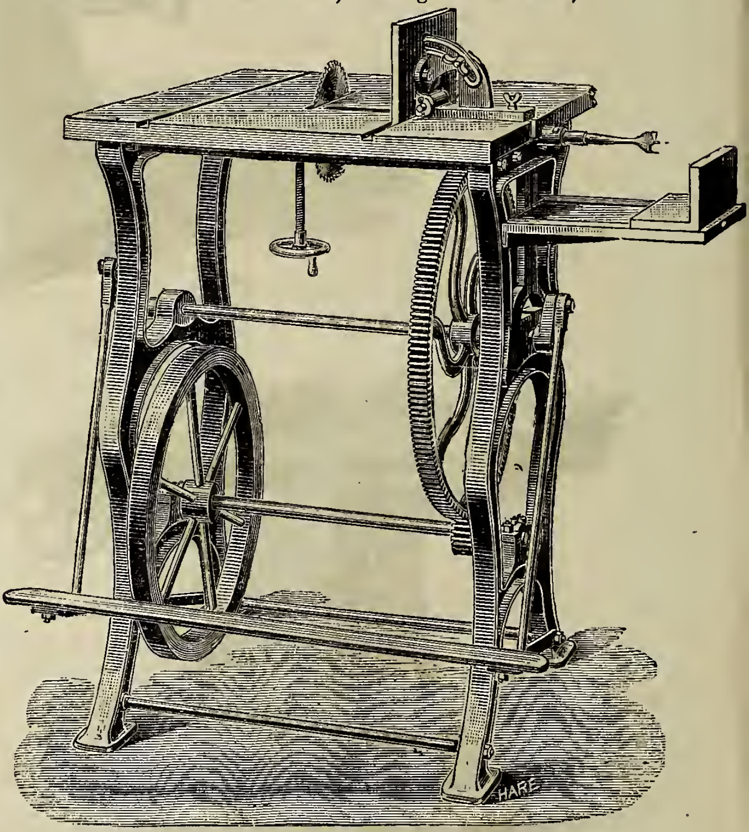


Fig. 7.—BRITANNIA CO., COLCHESTER.

I cannot insist too strongly upon the absolute need, in order to the attainment of the best results, of using the best saws, and of keeping them in the best possible order. A saw should leave scarcely any trace of its toothmarks on the stuff. When these marks are very apparent, it is clear that some teeth are standing out farther than their fellows, and doing nearly all the work. The teeth of circular saws should be as regular in the matter of "topping" and setting as those of milling wheels themselves. Time spent in sharpening and setting pays for itself in the economy of working up and finishing the material after it leaves the saw. Circular saws are topped with a stone while running in their bearings. The use of an automatic saw-set for these is advantageous. Some general remarks on the setting and sharpening of saws will be found in Vol. I., p. 370, of *The Practical Engineer*, and will in principle apply to all saws alike. Heating and straining of saws should be scrupulously avoided, since these produce buckle, and a saw once buckled can never, I believe, be restored by hammering to its original state of efficiency. As tending to reduce heating, frequent gulleting should be resorted to in order to maintain intact the depthing of the teeth, by which the dust is enabled to get away rapidly. The gasket used for packing should be kept well saturated with oil. The wetter and softer the stuff, the greater should be the amount of gulleting, set, and forward rake; while with the dry and hard materials, and for cross-cutting, these should be correspondingly reduced. A speed of from 7,000 to 9,000 feet at the periphery is considered most suitable for circular saws. J. H.

STATIONARY ENGINES AT THE MANCHESTER EXHIBITION.*

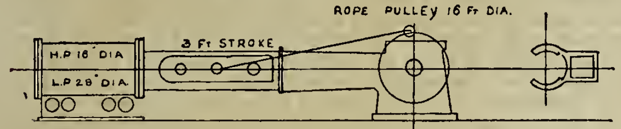
Gas engines, petroleum engines, and pumps are stationary engines, and were all represented at the Exhibition; but, as our time is limited, I think it will be more profitable if we restrict ourselves a little and confine our considerations to the steam engines which were used to generate the power required by the machinery at work at the Exhibition.

As pointed out in previous references to the Exhibition, so in the matter of these engines, but few novelties were to be met with; yet there was sufficient variety in design and construction to render a short consideration of the principal types not altogether unprofitable; and at the outset it may be observed that there was a sufficient difference in the construction and general arrangement to show that the manufacture of land engines has not yet reached that settled condition such as regulates the general construction of say kettles or dining tables.

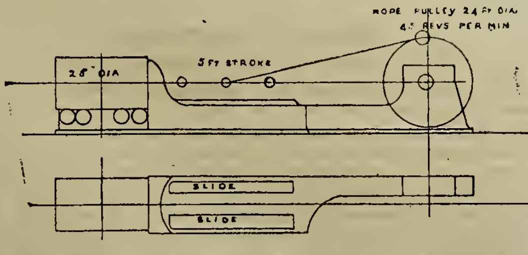
In these days of engineering progress and scientific design, it was very instructive to contrast the engines built in the East of England with those made in this district. The general characteristic of the former class was intention to catch the eye and suitability for stock; while, on the other hand, it must be confessed the local maker's work showed much greater evidence of particular design. An engine may be considered in reference—1st, first cost; 2nd, economy of steam; 3rd, suitability of the parts to resist the strains; 4th, convenience in reference to the accessibility of different parts, convenience for lubrication, &c. Regarding the engines at the Exhibition, however, we are not in possession of the necessary data; and, further, it would be unfair from various considerations to treat the matter in this way. The engines were not fully loaded, and were working generally in a way for which they were not designed. Thus most of the larger engines were intended to work condensing; but, as the necessary supply of water was not to be had, they had to exhaust into the atmosphere.

I will now go on to describe generally some of the principal engines, aided by rough diagrams, not to scale, but which will roughly illustrate some of the points to which I shall refer.

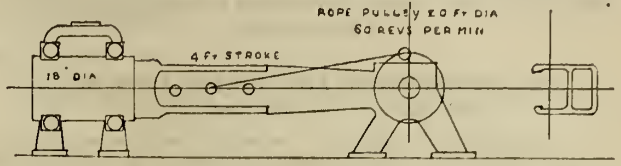
The compound engine, by Messrs. Daniel Adamson and Co. had h.p. cylinder 16in. diameter; l.p. 28in. diameter; both 3ft. stroke. The valve gear was of the Wheelock type, both steam and exhaust valves being below the cylinder, and both the steam and exhaust valves being driven by the same eccentric. Some members will doubtless remember seeing this gear when visiting Messrs. Adamson's works with the society a year or two ago. The cylinders were bolted on to the turned end of the bed, which was of the straight-line type. The slides, top and bottom, were bored out, as indicated on the sketch.



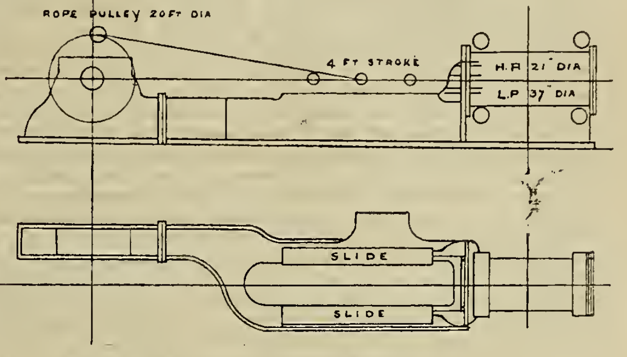
Messrs. Wood's non-condensing engine—25in. cylinder, 5ft. stroke—had both valves of the Corliss type below the cylinder, as in Adamson's. The valve cut-off gear was of a simple type, and the steam and exhaust valves had separate eccentrics. The cylinder was bolted on to a turned hood, formed on the end of the bed, and there were two slides formed in the bed, there being no top slide bars. The segment rope pulley was very large, and unshrouded, causing much wind.



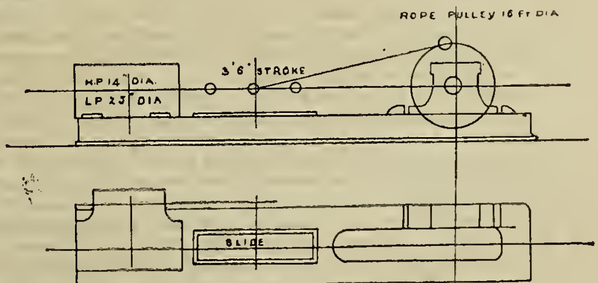
Messrs. Hick, Hargreaves, and Co.'s engine had 18in. cylinder, 4ft. stroke. The cylinder had the steam valves at the top of the cylinder, and the exhaust at the bottom, the cut-off gear being of their well-known type, and being controlled by an ordinary and a supplementary governor—the latter governor altering the length of the connection of the former to the cut-off valves, so making possible an absolutely constant average speed under varying loads. The bed was generally of the same type as Messrs. Adamson's, except that the slides were planed. This engine was, without doubt, the most graceful in the Exhibition.



Messrs. Musgrave and Son's engine was a compound, having h.p. cylinder 21in. diameter; l.p. 37in. diameter. The valve gear was similar to Hick's, insomuch that the steam and exhaust valves were arranged at the top and the bottom of the cylinder; the valve motion, however, appeared to be of excessive weight, some parts being more like engine cranks than the moving parts of an arrangement supposed to have a small frictional resistance. The cut-off gear was connected to the governor, and at first there was an arrangement of eccentric sleeve with ratchet wheels, which was supposed to have a similar action to the supplementary governor of Hick's engine. As this arrangement was taken off afterwards, I suppose that it did not give satisfaction. The bed was very massive, and was bracketed up and bolted to the cylinders, which rested on feet. There were two bottom slides—one on each leg of the bed—and no top slide bar. The forking of the bed enabled the front cylinder cover to be taken off—a good working advantage. Altogether, although this engine appeared clumsy, yet the general impression was that, although less elegant than some others, it yet showed evidences of working qualities not possessed by some of its more beautiful brethren.



The four engines just described were used to drive the main body of the Machinery in Motion Section. "Far in a wild, remote from public view"—*i.e.*, in the far corner of the electric lighting shed—was the compound engine of Messrs. W. and J. Yates; cylinders, 14in. and 25in. diameter; 3ft. 6in. stroke. This engine had a bed more of the old-fashioned type—the cylinder being bolted to the bed by feet, and the crank-shaft pedestal being separate from the bed, and held by packing between jaws and bolts. There was one planed slide in each bed, and this was of ample area. The valves were ordinary slide valves, and the cut-off in the high-pressure cylinder was by a transverse moving valve, which was actuated by cams, which were set forward or backward by the contact of the lower or upper bevel wheel of the governor sleeve.



The Lancashire Line.—The Isle of Man Steam Navigation Company has got out of its immediate trouble by the raising of some debenture stock at 6 per cent. A total—including some new shares—of £1,700 was subscribed at the meeting last week.

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* Paper read before the Owens College Engineering Society, February 7th, 1888, by Mr. E. G. Hiller, Assoc. Owens Coll.

CORRESPONDENCE.

We do not hold ourselves responsible for the opinions of our Correspondents.

BOILER REGISTRY AND INSPECTION BILL.

To the Editor of "The Practical Engineer."

SIR,—Referring to "Crankpin's" letter in your issue of the 9th, I am inclined to think he is dealing with a question with which he is not conversant, or he could not be guilty of such extraordinarily erroneous remarks as—"I cannot see how Boiler Insurance Companies can prevent explosions to any great extent. In the first place, we are all aware that it is not the thin, corroded, worn-out old kettles on the point of exploding that are chosen by the companies for insurance, but those that will bear the minutest examination by the inspector as to principle, age, position, and condition, &c., so that my idea of the present method of insuring a boiler is, that it insures the owner's pocket instead of the lives of the public." I cannot resist correcting such an impression at once. First, "Crankpin" is obviously not in a position to judge how the operations of Boiler Inspecting and Insurance Companies tend to prevent explosions, as otherwise he must have arrived at a different conclusion. The first object of these companies being to prevent explosion and loss of life and property, obviously no properly-managed company will accept for insurance "a thin, corroded, worn-out old kettle on the point of exploding." If it did, such conduct would be not only reprehensible and idiotic, but actually criminal, apart from the fact that that company would necessarily soon go to the wall. Their business consists in insuring boilers which are fit to work, examining them periodically whilst at work and thoroughly when off work, thus ascertaining their condition for pressure and fitness to continue working, and making such suggestions as are necessary to fit boilers for pressure when found defective, or condemning them utterly if too far gone to warrant expensive repairs. In almost every case owners comply with these conditions or suggestions. If they do not, and a fatal accident occurs, and though the pecuniary obligation still rests with the insuring company, the moral obligation lies on the owner, and a jury knows how to deal with him. These companies have for years been doing a valuable work, in some cases with complete success, the boilers found unfit for work by the inspectors being repaired or replaced, and explosions which would certainly otherwise have occurred without number have been prevented. Thus the lives of numberless persons have undoubtedly been saved during the boiler insurance era, some 30 years. The rest of "Crankpin's" letter is more to the point.—Yours truly, GOVERNOR.

To the Editor of "The Practical Engineer."

SIR,—The question of justice involved in the dismissal of a man after twenty years' experience is somewhat beside the mark. Whether it would be just or not for the Board of Trade to do so matters little, for as a matter of fact the Board of Trade would do nothing of the kind. With sea-going engineers there are certificates of service as well as of competency, so that there was no injustice done when the bill became law. The same would, of course, be done in this case. As to its preventing explosions, the statistics of "Chalkline," in *The Practical Engineer* of March 2nd, prove that it would not materially diminish such. The question is really a social one. The granting of certificates would have little result in raising the attendants' pay. This expectation, the hope of the engineman and the dread of his employer, appears to be largely visionary. The bill would be a benefit as an educational power, and by gradually raising the standard, as with marine engineers, the class would become better educated, though not necessarily better paid. Whether some easier method of education is not available may be questioned, but as to having any effect on the number of explosions, it would, I think, have none apart from compulsory boiler inspection. It is amusing to see the different estimates held of the common sense of the Board of Trade. One correspondent seems to think a severe study of mathematics would be expected, and that those most expert with the differential calculus would be regarded as the safest men to look after a boiler. Another correspondent displays unbounded confidence in the same board, and would rely more on their judgment than on a twenty years' character. The matter is, however, practically settled by the precedent of the certificates of service previously mentioned. OBSERVER.

POLLITT AND WIGZELL'S ENGINES.

To the Editor of "The Practical Engineer."

SIR,—Allow me to say a few words about the letters of "J. H." and "Study." No doubt the diagrams of "J. H." are fair good-working diagram; still I have seen better. But in reading his first letter I took it as a distinct challenge to all the readers of *The Practical Engineer* that they could not produce diagrams equal to his. Now, I think this is a very foolish idea for anyone to entertain, but I assume that "J. H." is young, and will perhaps learn better in time. As he says what results can be got at Wakefield ought to be got at Bradford, I say what results can be got at Dudley Hill ought to be got elsewhere. In "J. H.'s" first letter, he says his engine is of the compound tandem type, with Corliss gear, but when "Study" asks for initial pressure in low-pressure cylinders, and how far it is maintained, "J. H." says his low-pressure cylinder has only slide valves (and not Corliss gear, as before stated), and no cut-off valve. Now, whether this is a get out or not I cannot say, but it looks very like it. Then, as to "Study's" letter, I think it far too personal, and that no good will accrue from such letters, excepting the latter part of it (although he might think, with me, that the high tone of "J. H.'s" letter called for severe criticism). He should guard against personalities, and always be courteous and obliging even to his enemies, if he thinks he has any. And as for Pollitt and Wigzell's engines, I think, as a rule, we all find them crippled in the steam ports, and not properly proportioned in cylinder areas where they are compounded, but that is no reason why "J. H." should throw down the gauntlet to all other makers but Marsdens. I should like to see more friendly feeling in the letters addressed to *The Practical Engineer*, and if those who are able can help but a little, we might all reap a benefit from this correspondence.—I remain, yours respectfully, W. M.

Bradford, March 19th, 1888.

TALLOW CUPS v. SIGHT-FEED LUBRICATORS.

To the Editor of "The Practical Engineer."

SIR,—In answer to "Eureka," in last week's issue, I beg to say that I have two of the sight-feed lubricators at work, but if I had more engines under my charge I should put them on. The two that I have are lubricating six cylinders, one half-gallon for the pair of McNaught engines, and one pint for the pair of horizontal engines. The six pistons are together travelling at the rate of 2,037 feet per minute indicating about 700 horse. One lubricator is Bells', and the kind of lubricant I use is John Bells and Son's special cylinder oil, and the price 4s. 6d. per gallon. I am quite satisfied with the way it does its work, and agree with "Eureka," that bad oil is worthless, not only in the sight-feed, but also with the tallow cup. I might say that since I wrote my last letter I have tried the cup system for a few days on the horizontal engines, and the quantity used per day was three half-pints, and with the sight-feed one pint, or a saving of a half-pint per day. So I am more convinced than ever that the sight-feed is the best way to lubricate an engine.—Yours respectfully, SIGHT-FEED.

March 20.

ENGINE DIAGRAMS.

To the Editor of "The Practical Engineer."

SIR,—I am pleased to see published in your valuable paper a complete set of diagrams from a tandem compound engine, made by Messrs. Marsden, Yorkshire. I think the diagrams are very good, except for the expansion line being rather sluggish, which I presume to be caused by water in the indicator. I find by getting the S.V. of steam at point of cut-off, 58lb. pressure, and assuming the cut-off at one-third part of stroke, the steam consumption is 18lb. per i.h.p. per hour, which is very good work for 60lb. boilers. I am sorry to find no scale given with the diagrams, so that they could not be worked out properly. We must admit, from the figures, that the piston speed is in favour of the diagrams enclosed. "J. H." says that his low-pressure cylinder is without cut-off valves or plates. I beg to say that it is better without them with a fair average load upon the engine. I find by practical experience that half-stroke in the large cylinder is the most economical point to cut-off steam. I have had a little experience in working expansion in the large cylinder, but I fail to find where the economy comes in when a fair average load is on the engine; so my advice to "J. H." is not to trouble himself about expansion valves, as it only increases condensation. I conclude with saying that if I had a tandem compound engine to order I should have Corliss valves to the low-pressure cylinder as well as the high-pressure, to keep down the clearance space.—I am, yours truly, R. B.

Bradford, March 19th, 1888.

SMOKE CONSUMERS.

To the Editor of "The Practical Engineer."

SIR,—The smoke nuisance is a matter that seems to be greatly agitating the public mind just now, and it is a certainty that it will have to receive much greater attention in the immediate future than steam users and engineers have been accustomed to give it. For many weeks past a most vigorous and instructive correspondence has been going on in the *Oldham Chronicle* relative to the recently patented Assisted Draught Furnace and Smoke Consumer, of which the Oldham Boilerworks Company are the makers, and which is working with considerable success in a number of land and also marine boilers. One of the correspondents in last Saturday's *Oldham Chronicle* says: "The illustrations of the abatement of smoke which were given in a former issue of the *Chronicle*, and which could not be given in a more direct or honest manner than through the correspondence columns of the public press, have afforded the Sanitary Committee the opportunity of proving for themselves whether the furnace manufactured by the Oldham Boiler Works Company consumes the smoke at the expense of the coal. In a number of instances which were given it has been proved to demonstration that, so far from adding to the coal expenditure, this furnace, by its effective method of directing the air supply to the solid and gaseous fuel, develops to a greater extent the heating power of the coal, and, therefore, increases its economic value as compared with that which obtains in an ordinary furnace." There is every reason to believe that this furnace is a practical success, and so far as working examples go, it has covered a much larger field than many other smoke consumers to which attention has lately been directed; but would it not be serving a valuable and useful purpose if some of our public institutions—say the Steam Users' Association—would select a number of the most successful smoke consumers, and force them to a fair experimental test, and thus put the public in possession of a knowledge of the best means of abating the smoke nuisance?—Yours, &c., AN OLD OFFENDER.

[Several letters have been crowded out. Correspondents' letters, in order to secure insertion in the current week, should reach us by Tuesday morning. ED. *P. E.*]

QUERIES AND REPLIES.

PRIMING.—What are the chief causes of priming in marine boilers, and the remedy for same? I should like to be favoured with the construction of the hydrometer or salt gauge.—ANTI-PRIMER.

Answer.—One cause of priming arises from the pressure being taken off the surface of the water in the boiler on first starting the engine, and thus enabling the ebullition to go on with greater violence. But this is not the principal cause. The chief reason is that many foreign substances become mechanically mixed with the water—for instance, on getting up steam on a muddy river such as the Thames the mud will, by boiling, be driven up to the surface of the water, and accumulating there will prevent the free course of steam to the steam-chest, and consequently it forces up the water and mud before it. If there be any mucilage in the water, priming will also take place. A boiler will likewise prime as the vessel goes out of salt water into fresh, and *vice versa.* The first of the cases can be accounted for from the fact that fresh water boils at a lower temperature than salt water; and, therefore, as the fresh water enters the boiler previously heated, the ebullition is more violent. If the boilers prime while getting up steam, the dampers should be shut, the fires put back, and, at the same time, an extra quantity of water should be thrown in by the hand-pump, or auxiliary engine; by thus checking the ebullition, the priming will probably cease. If the boiler be liable to prime, the stop valves should be carefully closed, to prevent water from getting into the cylinders by the sudden ebullition, and only partially opened on first starting. The usual remedy to prevent priming is the introduction of tallow. Some boilers have a syringe on purpose, others have a stop-cock attached to the feed-pump, so as to charge it for one stroke with tallow. Priming has been successfully got rid of by placing two flat pieces of perforated iron near the steam-pipe, taking care that the perforations of the two plates are not in the line of the pipe. Any water that gets through the perforations of the first plate will impinge on the solid portion of the second, and be stopped. Seaward's salinometer, or salt-water gauge, shows the amount of salt in the boiler without the necessity of drawing off the water. It consists of a tube about ¾in. bore and 14in. long, fitted in a brass frame. This is connected with the boiler, so that when these cocks are turned on the water will rise in the tube to the same height as in the boiler. When the water is in the tube these two cocks are turned off, and one on the top of the tube opened, through which two balls are dropped into the tube. The first ball is made of such a specific gravity that it will *swim* when the water in the boiler is one degree denser than, and the second that it will *sink* when the water is one degree less dense than, the proper state. The top cock is then closed, and the two communicating with the boiler opened. If the water is at the proper degree of saturation, the light ball will swim, and the heavy one sink. As the water becomes saturated to a greater extent than is required, the heavier one will gradually rise; as the water becomes less dense than the point you wish to maintain it at, the light one will sink.—R. L. F.

MARINE PROBLEMS—PROPELLER SLIP.—A certain propeller is removed and replaced by another of the same pitch, but with greater "slip." What effect will this have on the speed of the vessel, the engines working at their highest power in each case? The revolutions would apparently increase, owing to the load being lightened, but how would this affect the speed of the ship?—Q.

Answer.—The second propeller, which "Q" states to have replaced the first one, although having the same pitch as the first, must have had a smaller propelling area, it having either a smaller diameter or a smaller breadth of blade, or, perhaps, a lesser number of blades. The lessened area of the acting surface of the second propeller, driven by the full power of the engines as before, will cause that propeller to revolve quicker than the first one, and the speed of the second propeller will be such as to absorb all the engine power as before. The resistance of the water to the action of the engines through this propeller being now the same in amount as in the first case, and the action of the propeller upon the water in driving forward the ship being also the same in amount as in the first case, the conditions will be as follow—the engines and propeller in this second case will go quicker than before, while the power developed by the engines and speed of the ship will be the same as before.—W. A.

Answer.—The same pitch, with greater slip, is practically equivalent to a propeller with smaller pitch, and no slip. It is often impossible to foretell what effect a change of pitch will have on the speed of a ship. It depends on what is the most effective speed for any given engine, and this depends on the size of posts, &c. If, with the original propeller, the engines developed their highest effective power on the thrust, then the increase of speed would cause more power to be wasted in friction than before, and the vessel would go slower. If the latter speed of engines, however, suited them best, so that more power in proportion was given to the thrust, then the speed of the vessel would increase, the indicated power in the cylinders being the same in both cases. With the best makers any change of propeller would probably cause lessened speed in the ship.—C.

AUTOMATICALLY CLOSING A STEAM VALVE.—Can any of your readers inform me of a method for automatically shutting, in a given short time, a steam valve that is opened by a movement which is too quick to be utilised for closing it, and where there is no other motive power available? I have heard that a wing valve would be suitable, but have no knowledge of such a valve, and should be obliged for a description of it, or any other method that would answer my purpose.—PISTON.

Answer.—In the absence of precise information, a separate valve for closing would seem to suit the case. The action of the valves spoken of are precisely the action of two wings, which rest outspread on a grating when shut. They give a large area of opening for a small lift, and might perhaps suit your correspondent. They are sometimes made of phosphor bronze, and uesd for pumps.—C.

STEEL PLATES.—Will some reader kindly give me a list of lengths and widths of iron and steel plates kept in stock by most merchants. What I want is to be able to design tanks, boilers, &c., without having to get them cut, as this increases the labour, and does not add anything to the strength.—H.L.C.

Could any reader inform me how I am to make the following: I want some aluminium tubes about 1½in. diameter, ⅛in. thick, and about 1½in. long, with flanges on the end. Can I buy the tubes ready made and solder the flanges on, or should I have to get sheet metal, and bend it over, and solder it up all along to make them? What would be the best kind of solder? Is aluminium very expensive, and who manufactures it?—W. Ll. P. W.

ILLUMINATING PAINT.—I should be glad to have the address of a maker of illuminating paint.—S. C.

STEEL CASTINGS.—Would any of your readers give me any information as to the theory of moulding and casting the above? Also if there is any work published on the subject?—MOULDER.

RAMSBOTTOM PISTON RINGS.—Will some reader give me a little information on expanding Ramsbottom piston rings, steel and cast iron, for cylinders 12in., 16in., and 20in. diameter, varying from ⅜in. to ⅝in. wide, and ¼in. to ½in. thick.—A. J.

ELECTRO-PLATING.—Could any reader kindly inform me how I best could re-electro.plate a tricycle? The cheapest and simplest style will oblige.—CLUB TANDEM.

STRESS ON A ROPE.—Will any reader assist me to calculate the stress on a steel rope 4in. circumference, working on an engine bank, dipping 1½in. in 12 inches. Load 14 tons.—STUDENT.

ENGINEERING JOURNAL.—I shall be glad to know the nature of the contents of "Der Machinen Constructeur;" also how often it appears, the price, and where it is to be got?—SUBSCRIBER.

TURBINES.—Will you or any of your readers kindly inform me what quantity of water per min. is required to drive a turbine of 6 i.h.p. with 6ft. to 9ft. of fall; also the diam. and speed of the turbine?—W. W.

COST-KEEPING.—Can any of your numerous readers recommend me to a good practical cost clerk, who can teach a reliable system of cost-keeping, not merely a theoretical system, but a practical one, involving the least labour to arrive at results?—R. H.

BRIGHT WORK.—What is the best thing to put on bright work, after polishing, to keep coke oven sulphur off? I use tallow, but it gets through that the next day.—ENGINE.

TO CORRESPONDENTS.

H. MATHER.—Draw a line to any scale, representing the circumference of the propeller, which can be done, knowing its diameter; then set up, from one wire of this line, at right angles to it, a line representing the pitch to the same scale. Join the upper end of this line with the extreme end of the horizontal line, and the angle between the two lines is the angle of the propeller.

E. K.—A fair average load would be ten horse-power, though the engine would drive more if economy were not considered.

ELY.—See the back numbers, containing articles on this subject.

W.—All queries are free.

R. GEMMILL.—Write the Editor of "Electrical Review," 22, Paternoster Row, London.

MISCELLANEA.

THE GLASGOW EXHIBITION.—The International Exhibition at Glasgow is to be opened by the Prince and Princess of Wales, on the 8th May.

THE ROYAL AGRICULTURAL SOCIETY.—A first prize of £30, and a second of £20 is offered at the next meeting for a hay and straw press worked by steam power; also first prize of £20 and second of £10 for Class II., press worked by horse power; and Class III., press worked by hand-power. In addition to the above, is a prize of £20 for a hand-power press, for old hay. Entries close on the 31st inst.

QUICKSAND BED AT CHICAGO.—It is reported that a quicksand bed recently discovered on the Lake front at Chicago is assuming alarming proportions. The ground is stated to be sinking slowly, and with it the tracks of the Illinois Central and Michigan Railroads. Many workmen are trying to keep the tracks level. The tunnel machinery and houses are also stated to be sinking. There are fears that the collapse may extend to the ground covered by the immense structures on Michigan Avenue, one block west.

OBITUARY.—William Kelly, the first importer of Chinese labour into America, died at Louisville, Ky., on February 11th. Mr. Kelly was born in Pittsburg. A despatch from Louisville says: "He discovered the air-boiling process in 1847, before Bessemer was heard of, and he always claimed that Bessemer got his first hint from workmen who had been employed at his Suanee furnace in Kentucky. In 1871 the United States Government refused to renew the Bessemer and Mushet patents, but granted a renewal of seven years to Mr. Kelly on his process. In 1854 Mr. Kelly imported the first Chinese labourers brought to America to replace the slaves in his foundries."

Discovery of Gold.—It is reported that a gold reef of extraordinary richness has been discovered near Gadak, in the Darwar District. Assays of hundreds of ounces are spoken of, and nineteen ounces of bar gold is said to have been obtained from a single cwt. of picked samples sent to London. The Bombay Government has been applied to for a mining lease of the land. Mr. Bruce Foote has reported favourably of the locality, and has recommended the exploitation of the Hattee Kuttee reef.

Stamped Mouldings.—Basswood may be enormously compressed, after which it may be steamed and expanded to its original volume. Advantage has been taken of this principle in the manufacture of certain kinds of mouldings. The portions of the wood to be left in relief are first compressed, or pushed down by suitable dies below the general level of the board, then the board is planed down to a level surface, and afterwards steamed. The compressed portions of the board are expanded by the steam, so that they stand out in relief.

Transference of Injector Business.—In connection with the approaching closing of the Manchester works of Messrs. Sharp, Stewart, and Co., the injector business has been transferred to the Patent Exhaust Injector Company, Limited, 4, St. Ann's Square, Manchester, who take over all drawings, patterns, templates, and stock, and will therefore be able to carry on the business, execute repairs, and supply all orders with the same accuracy and despatch as Messrs. Sharp, Stewart, and Co. The services of the most skilled workmen of Messrs. Sharp, Stewart, and Co. have also been secured by the Exhaust Injector Company.

Two-feet Gauge Railroads.—In Maine there are about four railroads built on the two-feet gauge, and their results are very satisfactory. One of the most important was recently inspected by a party of southern capitalists, who have a concession for a railroad in Honduras, and who contemplate building it on a narrow gauge. The road they inspected is sixteen miles long, and has steep grades and sharp curves, which are operated with ease by tank engines of Forney type. The passenger cars have one row of seats, accommodating one person each, on each side of the central gangway. The Honduras line would be free from difficult grades and curves, being a coast line.

New Blow-pipe.—In a lecture delivered before the Liverpool Section of the Society of Chemical Industry, Mr. Fletcher dwelt on the want of some simple method of obtaining a powerful source of heat under perfect control. Up to the present time the only practical methods had been either the use of a basket of live coke or a blow-pipe connected to the nearest gas supply. Neither of these methods was satisfactory in many cases, and, to overcome the difficulty, he had devised some special forms of blow-pipes which can be used with the ordinary coal gas supply and compressed oxygen made by the Brin process. These blow-pipes are essentially different from the usual form, and also from the well-known mixing jet, the latter requiring both gas and oxygen to be equally compressed, which at once excludes it as an emergency arrangement for repairs and accidents.

Ventilation of Sewers.—A method of sewer ventilation, which completely deodorises and disinfects the escaping gas, has been introduced by Mr. Keeling. The invention consists of a ventilating column, resembling an ordinary lamp-post in appearance, which communicates with the sewer. At the base of the column is placed an air gas-burner of special design, surrounded by a conical iron casing and surmounted by two conical chambers. A very high temperature is thus created inside the chambers and cones, causing an up-draught from the sewer, the vitiated gas from which comes in contact with the gas flame and with the ribbed surfaces of the heated iron cones above it. The cones are arranged so as to baffle the draught, and cause all the air to come in contact with the heated iron, in this way completely destroying any living organic matter in the sewer gases. These ventilators, which are surmounted with ornamental gas lamps, have been under trial for some time past at Richmond, Ealing, Leicester.

Boiler Explosions.—The following circular letter has been sent to various sanitary authorities throughout the country: "Board of Trade, Marine Department. Boiler Explosions. Sir,—I am directed by the Board of Trade to transmit to you, for the information of the local authorities, copies of a handbill calling attention to the conviction of the owner of a steam boiler for having neglected to comply with the provisions of the Boiler Explosions Act, 1882, by not sending to this office a notice of an explosion which had occurred on his premises. The board have reason to believe that many owners of steam boilers are still unacquainted with these requirements, and that consequently cases of explosion sometimes occur which escape the investigation provided for by the Act. As nearly all the explosions arise from preventable causes, it appears to be very desirable that in every instance an inquiry should be held and a report thereon published. The board having had the handbill printed, it has occurred to them to inquire whether, in the interests of public safety, the sanitary authority of your district might not wish to have a few for distribution. If so, the board will, on hearing from you to that effect, cause as many copies to be sent to you as you may think necessary.—I am, sir, your obedient servant, Thomas Gray. The Clerk to the Urban Sanitary Authority."

SELECTED PATENTS.

March 9th.

3630 Axle Guard, J. Lockhart, Glasgow.
3640 Uncoupling Railway Trucks, W. Fielding, Halifax.
3651 Governor, P. Evans, Liverpool.
3652 Steam Engines, J. C. Stitt, Liverpool.
3656 Pulsometers. E. Lund, jun., London.—[Complete Specification.]
3659 Sheet-Metal Cylinders, A. J. Boult, Middlesex. (C. H. Wonson, United States.)—[Complete Specification.]
3660 Calcining Ores, W. J. Howarth and J. Graham, Manchester.
3664 Wood-turning Machinery, D. H. Bacon, London.—[Complete Specification.
3667 Wire-twisting Machine, H. A. Walker, London.
3673 Lamp-burners, J. M. Rowatt, London.
3675 Piston and Gland Packing, J. Walker, London.
3676 Lubricators, J. Walker, London.
3678 Electrical Signalling on Railways, W. G. Olpherts, Gray's Inn Chambers, London.—[Complete Specification.]
3681 Tube Stoppers for Steam Boilers, D. Pugh, London.
3685 Electrical Switches, S. Sharp, J. M. V. Money-Kent, and H. J. Payne, London.—[Complete Specification.]

March 10th.

3690 Electrical Signalling Apparatus, E. Dunn, Staffordshire.
3695 For Preventing Down Draught in Chimneys, R. Roberts, Liverpool.
3701 Firing Tubes of Gas Engines, J. A. Fisher, Liverpool.
3710 Electro-Magnetic Motors, J. Tweeddale, Glasgow.
3711 Steering Gear, R. Richardson, Glasgow.
3712 Machines for Lifting Heavy Bodies, G. C. Marks, Birmingham.
3713 Steam Boilers, R. Norton, Ipswich.
3715 Vertical Steam Boilers, J. R. Jefferies, Ipswich.
3716 Lock Nuts, E. C. Ibbotson, Sheffield.—[Complete Specification.]
3722 Furnaces for the Production of Steel, W. Muirhead, London.
3723 Regulating and Indicating Water Level in Steam Boilers, M. Sutherland, Glasgow.
3740 Combined Cut-out and Switch, A. Bernstein, London.—[Complete Specification.]
3741 Ore-Concentrating Machinery, C. Appleby, London.
3747 Doors of Railway Carriages, J. Smith, London.
3749 Driving Gear for Screw Propellers, P. W. Willans, London.
3751 Fish Plates for Rails, O. Imray, London. (G. S. Lee, United States.) [Complete Specification.]
3756 Gas and Oil Motor Engines, F. W. Crossley, London.
3757 Calculating Machine, G. A. Bahmann, London.
3762 Feed-water Purifier, S. H. Mosher, R. Forsyth, and T. J. Wheeler, London.—[Complete Specification.]
3765 Automatic Brake for Marine Engines, G. Kingdon, F. C. Simpson, and F. Strickland, London.

March 12th.

3767 Working Railway Signals, C. F. Whitworth, Lincolnshire.
3770 Producing Copper Castings, R. Murray, Glasgow.
3773 Diminishing Corrosion of Screw Propellers, W. C. Wallace and R. D. Smillie, Glasgow.
3774 Lubricating Cream, J. L. Wade, Glasgow.—[Complete Specification.]
3776 Extracting Ferrules from Boiler Tubes, J. C. Arnell, Hampshire.
3780 Heat-radiating Screen, W. H. Prestwich, Tottenham, N.
3783 Oil Lamps, S. R. Williams, Birmingham.
3784 Locks and Latches, F. J. J. Gibbons, Bloxwich.—[Complete Specification.]
3785 Water-heating Apparatus, J. Winterflood, London.
3786 Type-writing Machines, T. D. Worrall, Guidhall.
3793 Metallic Alloys, J. Y. Johnson, London. (La Société Anonyme Le Ferro-Nickel, France.)—[Complete Specification.]
3799 Pistons, C. Edmeston and A. Edmeston, London,
3800 Air Pumps, J. McNaught and W. McNaught, London, W.C.
3801 Rotary Engine, J. Selwig, London.—[Complete Specification.]
3803 Sliding Cocks, H. J. Haddan, London. (Marius Emery, France.)
3804 Manufacturing Wire Fabric, F. Ainsworth, London.—[Complete Specification.]
3806 Cupolas for Melting Iron, A. Leslie, London. (A. S. Massey, British India.—[Complete Specification.]
3812 Combined Switch and Holder, E. L. Berry and G. Franke, London.
3813 Side Couplings for Railway Rolling Stock, S. Sudheim, London.—[Complete Specification.]
3819 Spark Arresters, W. P. Thompson, Liverpool. (A. Jessl, Bohemia.)—[Complete Specification.]
3822 Miners' Lamps, J. Moss, Liverpool.
3823 Extraction of Metals from Complex Ores, J. C. Butterfield, Holborn.
3828 Syphons, J. Davey. Middlesex.
3829 Pressure Fluid Motor, A. Barclay, London.

March 13th.

3831 Wood-slicing Machine, E. Bradley, London.
3837 Lifting Jacks (complete specification), F. H. Sleeper, London.
3838 Regenerative Gas Lamps, A. O. Brown, Glasgow.
3839 Railway Ties (complete specification), J. Jacobs, London.
3840 Anti-priming Apparatus, H. G. Warner, Wandsworth.
3857 Annealing Furnaces, J. Halfpenny and H. Halfpenny, Wolverhampton.
3858 Metal Fencing, H. Smith, Birmingham.
3859 Machinery for Chipping, J. W. Hall, Birmingham.
3863 Burning Liquid Fuel in Steam-boiler Furnaces (Complete Specification), J. B. Hannay and R. P. Doxford.
3870 Ships' Fittings, J. Wing, Kent.
3873 Keys in Railway Chairs, J. E. Crossland, London.
3876 Rotary Engines, T. Henderson and F. Broadbent, London.
3877 Railway Chairs, G. W. Willford, Sheffield.
3878 Self-acting Mules, J. Whitehead, London.
3879 Prevention of Down Draft, L. Redmayne, Blackburn.
3883 Type-writers (Complete Specification), A. J. Boult, Middlesex.
3885 Pulleys, I. Cordingley, Middlesex.
3892 Metallic Fencing, J. C. Mewburn, London. (Anatole Bère, France.)
3900 Pulverizing Ores, T. R. Jordan, London.
3901 Vent Plugs for Steam Radiators, H. H. Lake, London. (E. P. Waggoner, United States.)—[Complete Specification.]
3906 Injector, S. Roberts, Surrey.
3909 Rotary Engine, W. W. Wardle, London.
3910 Utilising Liquid Fuel in Steam Boilers, C. R. Hoops, London.—[Complete Specification.]
3913 Machines for Rolling Round Metal Bars, J. Farmer, London.
3914 Locomotives, E. Edwards, London. (Emile Oury, Algeria.)
3915 Heating and Purifying Feed Water, C. Appleby, London.

NOTICE TO NEWSAGENTS AND SUBSCRIBERS.

Numerous complaints having been made to us by Subscribers of the difficulty they experience in obtaining copies of the *Practical Engineer* in certain districts, we have to state that the Journal can be obtained by any Newsagent through the ordinary trade channels, and no difficulty should therefore exist in obtaining copies by order of any Newsagent.

For the information of the trade, we may state that copies can be obtained from either of our Offices in London or Manchester, or from any of the following wholesale houses, who are also supplied with Contents Bills for the use of the trade:—

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W. H. SMITH & SON, Blackfriars Street, Manchester.
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J. MENZIES & CO., Drury Street, Glasgow.
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EDITORIAL NOTICES.

All communications for the Editor of this Journal should be addressed to 6, Victoria Station Approach, Manchester.

Communications intended for insertion in the current week's issue should reach us not later than Tuesday Evening.

We cannot undertake to return rejected manuscripts or drawings unless accompanied by a stamped and directed envelope.

Contributors are requested to write on one side only of the paper. Sketches should be sent on separate sheets.

TO ADVERTISERS.

Advertisements intended for insertion in the current issue should reach us on Wednesday morning at the latest.

Important Notice to Newsagents and Subscribers.

Our Publishing Offices in London are now at 11, PATERNOSTER BUILDINGS, E.C., where the Trade will in future be supplied.

Simultaneously with the above change, our PUBLISHING OFFICES in MANCHESTER have been REMOVED from Grosvenor Chambers, Deansgate, to more commodious and convenient premises at 6, VICTORIA STATION APPROACH, where all communications intended for the Manager or Editor should, in future, be addressed.

THE
PRACTICAL ENGINEER.
MARCH 30TH, 1888.

TRANSMISSION OF POWER.—VII.

ELECTRICITY—I.

THE transmission of power to a distance by means of an electrical current is quite a modern development, and great reduction in cost has been brought about during the past few years. With the electro-magnetic motor the system was generative, and the production of power very costly; but with the dynamo machine the current acts merely as a means of transmitting the power produced by an independent motor, which may be either a natural source of power, such as a waterwheel or turbine, or obtained by utilising oil or coal by means of prime movers situate at or near the oil wells or collieries.

The limit of distance to which power can be economically transmitted is soon reached when wire cables, hydraulic power, or compressed air are the means, and of these hydraulic power has perhaps been found the most adaptable, with, however, serious disadvantages. The limit of transmission by electricity is much greater than by any of the methods before mentioned.

The limit is dependent upon the quantity of electricity that can be transmitted by the conductor. To convey a large quantity requires a conducting wire of a proportionate section, and this, for long distances, introduces the element of cost.

Mechanical efficiency depends on the magnetic energy, and this is more nearly related to the quantity than the intensity of the current. The conductor resistance is inversely proportional to the area of the section and directly proportional to the length. Thus, if the distance is doubled, the area of the section should be doubled; or, if the distance be increased n times, the area of section of the conductor must be increased n times in order to transmit the equal power from the same machines. Thus, other things remaining the same, the cost of the conductor varies as the square of the distance. But this supposes that there is no increase in power or alteration in the machines, but most likely an alteration would be made if the distance were greatly increased, and the cost of the conductor system would be reduced to a new standard.

Messrs. Higgs and Brittle, in a communication made to the Institute of Civil Engineers in the year 1877, discuss the question of the maximum percentage of power that can be given out by the second dynamo machine, and consider that the greatest work is yielded by the second machine when the strength of the current given by the first machine or driver has been reduced to one half by the induced current produced by the revolution of the second machine; so that, supposing two equal machines arranged for the transmission of power, the amount reclaimable from the second machine will be 50 per cent of that employed upon the first, and the number of revolutions of the armature of the second machine, corresponding to the maximum of work reclaimed, will be half the number made by the first

The same authors also establish the fact, by experiment, that the loss of efficiency of transmission varies directly as the resistance in the circuit.

An interesting and instructive application of electricity for the transmission of power has been made by Messrs. Brain at the Trafalgar Collieries, in the Forest of Dean, where the power of a steam engine at the surface is changed into electricity and conveyed to small pumps in the far end of the workings with a very good economic result. Mr. Frank Brain described the whole of the apparatus, and gave details of the work done and its cost, in a paper read before the South Wales Institute of Engineers a short time ago.

About four years ago an electric pumping plant, performing 13 H.P., was got to work, and has given entire satisfaction; and about two years ago a plant of 23 H.P. was got to work with similar results. Now, a much larger plant has been put in to deal with the main feeder of water in the deep workings of the colliery. The pump and motor are placed at a distance of 1,650 yards from the shafts, and force water a vertical height of 300ft. to the pit bottom.

Previous to May last, this water was raised by means of one of Hathorn, Davey, and Co.'s water-power pumps, in conjunction with a 7in. double plunger pump, made by Messrs. Pearn and Co., of Manchester, and having 10in. steam cylinders working 14in. stroke.

The new pump has double plungers, 9in. diameter, working 10in. stroke, made by the Lilleshall Iron Co., Limited. It is driven by a link belt running on a 54in. pulley on the pump from a 14in. diameter pulley on the motor. When the pump makes 25 strokes the motor makes 650 revolutions.

The motor was made by Elwell Parker, Limited, and is described as a 12in. machine; maximum speed, 650 revolutions; output, 13,000 watts. The electric current is conveyed to it by a copper cable 2,000 yards long, 19/16 wires, and wrapped with compounded tape. This is enclosed in wooden boxes in the shaft only. Along the roads it is supported by earthenware insulators placed at intervals of about ten yards. The return cable is an old iron pit rope, about four inches in circumference, which is stapled to the road posts. The generator placed on the surface is another Elwell Parker 12in. machine. Its maximum speed is 950 revolutions, and output 17,000 watts. The steam engine which drives the generator has a single 16in. cylinder and 12in. stroke, and works with 35lb. steam pressure; it is an old one, and indicated 5 H.P. when running empty. The usual electrical instruments (volt-meter, am.-meter, &c.) are placed in the engine-house, and a magnetic cut-out is provided in the main circuit.

We purpose to give some particulars of the results obtained in our next article.

MANCHESTER ASSOCIATION OF ENGINEERS.

At a well-attended meeting of this association, held on Saturday night, Mr. H. Guthrie read a paper on "The Thermo-dynamic Analysis of the Gas Engine." The paper was in continuation of one Mr. Guthrie read before the association last year. In the present paper he referred to the three types of gas engines now in use, and quoted Mr. Dugald Clerk's statement of their relative dynamic values. While not disputing Mr. Dugald Clerk's figures as far as they go, he said that they did not properly represent the relative values of the three types of engines, and that when the analysis was carried further different deductions were to be drawn than those arrived at by Mr. Clerk in the paper which he read in April, 1882, to the Institution of Civil Engineers. The great feature of the gas engine of the present day was compression, by which we get greater power in a less space, and consequently less loss by radiation and conduction, less wear and tear, and less cost of production. A feature absent from the gas engine of the day is sustained pressure, and this feature he considered to be absolutely essential for many purposes. Commotion was another important feature which we did not get in the modern gas engine, at any rate to the degree that is necessary for rapid combustion. Hot cylinders and no water jacket was about the greatest necessity of all, and seemed to furnish the only hope of materially augmenting the efficiency of the present engine, for on all hands it was admitted that by cold cylinders fully 50 per cent of the developed energy was now lost. He described in detail the method by which, in his opinion, those very desirable features were to be obtained, and said he hoped that by its adoption the efficiency of the gas engine would be increased, its cost lessened, and a wider field of usefulness opened for it. We hope to reprint Mr. Guthrie's paper *in extenso* in an early issue.

LITERATURE.

The Watchmakers' Handbook. Translated from the French of C. Saunier, by J. Tripplin, F.R.A.S., and E. Rigg, M.A. Second Edition, pp. 498. London: Crosby Lockwood and Son.

The second edition of this eminently practical and useful book has been enlarged by an appendix, containing brief notices of some new watchmakers' tools brought out since the first edition of the work was published. In recent years watchmakers' lathes have been very considerably improved, and the same may be said of the small hand-tools used by jobbers, and many of these are duly noticed in the appendix. The volume can be recommended to the ordinary watch jobber and repairer, containing as it does an immense amount of valuable practical information concerning the operations performed by him, the working of metals, and descriptions of tools, &c., in an accessible form, which will be of great assistance to him and handy for reference. The very copious index and numerous cross references enhance very much the value of the book.

Flour Manufacture: A Treatise on Milling Science and Practice. By Friedrich Kick; translated by H. H. P. Powles; pp. 367. London: Crosby Lockwood and Son.

This handsome volume is an example of the kind of literature that is common in Germany, but is conspicuous by its absence in English technical literature. Milling is here treated as a science, and the whole subject is examined from a scientific standpoint before entering upon the practical details of the work of reducing the grain to flour. Nearly all recent German technical literature has this merit, and it is a feature our own writers would do well to imitate. The English works dealing with the subject of milling are very scanty, and hence this translation of Dr. Kick's volume will be all the more valued by practical millers. The principles upon which milling should be based are clearly explained, and the text is also intended to qualify a man to become a head miller or manager, as well as to enable the milling engineer to obtain that knowledge of the properties of the various cereals on which the design and arrangement of the machines and mills depend. The book is, therefore, a complete milling technology, and the thoroughness of the method of treatment does credit to the author. As, however, the subject matter of the book is mostly outside the scope of this journal, we shall only indicate the heads of the various sections. Part I. deals very fully with the structure and diseases of the various kinds of grain, and the next with its preservation. Part III. relates to the preparation of grain for grinding, and Parts IV. and V. with grinding mills, hursts, and roller mills respectively. The next two divisions relate to dressing of the ground produce and purifying middlings. The different methods of milling are next described, and then mixing, storing, drying, &c., of flour, and the last part treats of mills as industrial establishments. A most valuable feature of the work is the sheets of engravings, twenty-eight in number, at the end of the volume, which very fully illustrate the text. All the drawings are made to scale, and are practically working drawings, and hence will compare most favourably with the meagre sketches we often see in books of a technical character. We trust the volume will find its way into the hands of all head millers, managers, and milling engineers.

Obituary.—Mr. Robert Hadfield, the founder of the Hecla Works, Attercliffe, Sheffield, died at his residence, Broombill, last week. The Hecla Works have long been famous for steel castings.

AN ENGINEER'S LIFE AT SEA.—IV.

BY A SEA-GOING ENGINEER.

(Continued from page 124.)

It will be well for our young engineer if he has made good use of his opportunities while the sea is calm. Perhaps it will be in the Bay of Biscay that he gets his first initiation into rough weather. In that home of the winds, frequent gales and rough cross seas, though much exaggerated, are real and unpleasant. Those who know the Bay best fear it least, but the track across it is usually a rough one, and can rarely be accomplished with dry decks.

In the engine-room the beginning of rough weather is soon detected by the "racing" of the engines. Should a governor be available it is then put on, but most probably there is none on board. In this case, the chief engineer will come down and slow the engines till the racing ceases, and will, before returning on deck, give strict orders that they are on no account to be opened up again without his sanction, even though the captain himself should urge it. As the weather gets worse, the engines are put slower and slower, till there is just enough steerage way on the ship, or till the speed could not be reduced without stopping the engines altogether. Should the racing still continue, then "stand-by watches" are arranged, so that one engineer can control the throttle-valve while another looks after the engines.

To throttle engines properly, much practice is needed. The inexperienced wait till the speed of revolution begins to increase, and then close the throttle, but this is too late to stop the race. Other engineers wait till the stern begins to rise, but as this method is very uncertain, it entails much needless work. Though the stern may be rising, it does not follow that the propeller is getting out of the water. It may be deep in the wave and rising with it. The position of the propeller in the wave depends on the number of waves on which the steamer rests, and this depends on the length of the ship, the length between waves, and the angle formed by these two. It will be noticed that before every race the engines slow down. The average duration of this slowing is readily observed, and the time to throttle is just at the end of the slowing, and *before* the speed of revolution has begun to increase. To one experienced in throttling, and with a reliable throttle-valve, it is quite possible to throw the engines full open in the wildest weather, and yet keep them running with almost perfect steadiness by hand alone. This, however, should never be done except in such an emergency as a threatened collision, for the slightest error of judgment might cause the engines to break down and bring disaster on the ship. Apart from this risk, it will be found impossible to keep up such throttling long, as it is too exhausting to brain and hand.

During bad weather the fear of breakdowns is ever present to the engineers, and yet the lives of all on board often depend on the steady running of the engines. Even progress about an engine-room is not wholly free from danger. Short runs must be made between the rolls, to the nearest object to hold on by, and the danger of being thrown into the machinery is by no means illusory. A fall on the slippery platform frequently slides the most wary over to the engines, till he is brought up at the foot-guard round the crank-pits. This guard should never be allowed to fall into disrepair, or life may be lost. Sacking should also be laid on the iron plates to give a firmer foothold. Fortunately, however, the slowing of the engines reduces risk of heating of working parts to a minimum. All nuts, however, on pumps, crossheads, and links, must be carefully watched, or the almost unavoidable variations of speed of the engines may loosen them. The slackening of a nut on a link, or of one on a plunger, may give no warning unless seen, till the overstrained bolt breaks.

Perhaps, however, after all, the firemen have the worst of it in rough weather, though the slowing of the engines, by reducing the demand for steam, is also to them a benefit. They cannot hold on with one hand and fire with the other, but have to balance themselves, and throw the coal in as best they can. If the chains of the fire doors are kept in good order, there will be no shutting to of the door with a bang as soon as the fireman, with a shovelful of coal in hand, has poised himself for a throw. In very bad weather barricades, about a foot high, should be fixed across the stokehole plates, fore and aft, so that there will be no noisy clattering of a rake or slice, or an ash bucket, across the stokehole to the danger of the firemen, who run quite enough risks already from the coal, or from being thrown down on the plates.

As soon as bad weather comes on the skylight covers should be fastened down; but, as this puts the engine-room in darkness, it is usually postponed as long as possible. A shock from a larger wave than usual, a crash, and a shower of glass from the skylight, with a downpour of water, and an engine-room full of steam from the hissing cylinder-covers, tell the engineer it has been put off too long. Then a tarpaulin is drawn over by the sailors, and all has to be battened down, while the lamps are lit in the darkened engine-room.

The relief of watch is always welcome, and the one relieved slowly, but with satisfaction, climbs up the reeling ladder, stopping to hold on at every few steps. The heavy engine-room door is got open, and happy is he when he has reached his room in safety. Then off go his clothes, and into his bunk he climbs, the only tolerable place on a day like this; there, securely jammed in, he sleeps, or smokes, or reads, till the next uncomfortable meal comes round, or still more uncomfortable watch, consoling himself as he can with the reflection that, in two or three days, the weather will most probably moderate.

LESSONS IN MECHANICAL DRAWING.—XIV.

By Prof. A. Maclay, B.Sc., C.E.

ON DRAWING CURVES FROM EXPERIMENTAL DATA (*continued*).

Exercises.

Ex. 57, Figs. 72, 73, and 74 (page 113).—From the figures given in Table I., draw the strain diagram, the curves of extensions and sets, in the manner previously described. Scale for the weights, 1in. per ton; for the elongations and sets, 20 to 1, or 2in. to $\frac{1}{10}$in.

Ex. 58.—In the same manner draw the curves of compressions and sets on cast-iron bars of the same length and section, from the figures in Table II., below. Scale for the weights, $\frac{1}{2}$in. per ton; the compressions and sets to be magnified ten times.

Table II *

No. of Expt.	Stress: Compressive. Loads in tons.	Strain: Compression.	
		Elastic Compression in inches.	Residual Compression or Set in inches.
	A	B	C
1	·92	·01875	·00047
2	1·84	·03878	·00226
3	2·76	·05978	·00400
4	3·68	·07879	·00645
5	4·60	·09944	·00847
6	5·52	·12030	·01087
7	6·44	·14163	·01405
8	7·36	·16338	·01712
9	8·28	·18505	·02051
10	9·21	·20624	·02484
11	11·04	·24961	·03220
12	12·88	·29699	·04300
13	14·72	·35341	·06096
14	16·56	·41149	·08421

(Draw the heavy lines downwards from the curve in this case, so as to represent the shortening of the bars.)

Ex. 59.—A slip of pine (4ft. by 1in. by 1in.) rests freely on supports 3ft. 4in. apart, and is loaded in the middle with the results given in Table III. Draw the curve of deflections. Scale for loads, 20lb. per inch; deflections full size.

Table III. †

No. of Experiment.	Stress: Bending. Load in lbs.	Strain: Elastic Deflection in inches.
	A	B
1	14	0·19
2	28	0·37
3	42	0·55
4	56	0·74
5	70	0·94
6	84	1·13
7	98	1·35
8	112	1·61
9	126	1·95
10	140	2·37

† From Table XXIII., Ball's "Experimental Mechanics."

Ex. 60.—Draw the curves of deflections and sets taken by cast-iron bars 3½in. by 1½in., resting on supports 13ft. 6in. apart, and loaded in the middle, according to the experimental results given in Table IV.

Scale for loads 1in. per cwt.; deflections and sets full size.

TABLE IV.*

No. of Expt.	Stress: Bending. Loads in cwts.	Strain: Deflection.	
		Elastic Deflection in inches.	Residual Deflection or Set in inches.
	A	B	C
1	¼	·181	·0016
2	½	·375	·0068
3	1	·768	·0192
4	1½	1·184	·0468
5	2	1·632	·0914
6	2½	2·105	·1486
7	3	2·604	·2266
8	3½	3·169	·3292
9	4	3·756	·4574
10	4½	4·402	·6078
11	5	5·035	·7854
12	5½	5·777	1·038
13	6	6·565	1·287
14	6½	7·610	1·707
15	7	8·730	2·186
16	7½	9·887	2·691
17	8	10·700	3·006

* The figures in Tables II. and IV. are taken from Tables III. and XXVIII. of Anderson's "Strength of Materials."

Ex. 61.—From the figures given in Table V.‡ draw in the one diagram a comparative set of strain curves, curves of extensions, and sets for bronze, cast-iron, wrought-iron, and steel. The loads are given in tons per square inch; scale, 1in. per ton. The extensions are recorded in units of $\frac{1}{10000}$th part of the length; scale, 20 units per inch.

TABLE V.

No. of Exp.	Stress: Tensive. Load in tons per square inch.	Strain: Extension (in 0·0001 of length).							
		Cast Bronze.		Cast-iron. (Styrian, for guns.)		Wrought-iron. (Styrian.)		Cast-steel. (Krupp's, for guns.)	
		Elas.	Resid.	Elas.	Resid.	Elas.	Resid.	Elas.	Resid.
1	·635	10	0	2	0	4	0	1	0
2	1·270	15	0	10	0	9	0	3	0
3	1·905	25	0	15	0	11	0	7	0
4	2·540	35	0	22	0	14	0	12	0
5	3·175	47	1	27	0	18	0	16	0
6	3·810	56	4	33	0	22	0	20	0
7	4·445	66	7	38	2	24	0	25	0
8	5·080	77	11	47	4	27	0	30	0
9	5·714	88	20	54	5	31	0	34	0
10	6·349	101	32	61	6	35	0	39	3
11	6·984	110	52	68	8	37	0	44	5
12	7·619	120	96	76	10	40	2	50	7
13	8·254			84	14	42	3	55	10
14	8·889			92	19	45	4	60	14
15	9·524			101	24	48	5	65	20
16	10·159			110	30	52	6	71	31
17	10·794			120	35	57	7	76	38
18	11·429			130	50	62	8	81	48
19	12·064			142	65	67	8	85	
20	12·699			157	81	72	9	90	
21	13·334					77	10	98	
22	13·963					82	12	110	
23	14·604					88	14		
24	15·239					93	16		

Ex. 62. Fig. 75.—Draw a stress diagram from Table VI. below, which shows the results of an experiment on the tensile strength of a bar of mild steel. The lines to be shown are: (1) The ordinary curve of tensile strength from the figures in columns A and C; (2) The curve of cohesive strength from the figures in columns B and C. Scales: Stress, five tons per inch; strain (the extension), four times actual length.

TABLE VI.*

No. of Expt.	Stress.		Strain.	
	Per sq. in. of original area of section.	Per sq. in. of reduced area of section.	Extension on 8in. of length.	Contraction of sectional area.
	A Tons.	B Tons.	C Inches.	D Sq. in.
1	13·93	13·93	·01	1·0000
2	17·41	17·51	·02	·9945
3	15·17	15·25	·04	·9945
4	14·91	15·13	·05	·9852
5	15·53	15·77	·06	·9852
6	16·34	16·67	·08	·9799
7	16·96	17·31	·10	·9799
8	16·69	17·02	·13	·9764
9	17·23	17·80	·20	·9677
10	21·43	22·51	·30	·9677
11	23·43	25·10	·40	·9331
12	24·46	26·20	·50	·9331
13	25·50	27·84	·60	·9157
14	26·30	29·00	·70	·9071
15	26·78	29·81	·80	·8985
16	27·05	30·68	·90	·8820
17	27·23	31·15	1·00	·8741
18	27·53	31·81	1·10	·8655
19	27·98	32·96	1·20	·8490
20	28·35	33·20	1·30	·8443
21	28·35	33·67	1·40	·8325
22	28·35	34·32	1·50	·8168
23	28·35	34·66	1·60	·8089
24	27·89	34·81	1·65	·8011
25	27·94	35·09	1·70	·7963
26	27·85	35·46	1·75	·7854
27	27·89	35·73	1·80	·7806
28	27·67	36·33	1·85	·7619
29	27·67	36·69	1·90	·7543
30	27·50	37·15	1·95	·7389
31	27·32	38·54	2·00	·7088
32	27·10	39·05	2·05	·6941
33	26 71	40·45	2·10	·6603
34	26·20	42·14	2·15	·6221
35	25·05	45·21	2·20	·5541

* From Experiments by E. Richards, Journ. I. & S. Inst., No. 1., 1882.

Ex. 63.—Draw a strain diagram—a curve of contraction of sectional area—from the figures in columns A and D, Table VI. Scales: stress, 5 tons per inch; strain, 5in. linear to 1 square inch.

Ex. 64.—Fig. 76 shows a series of stress curves—in this case, curves of resistance to torsion—which were automatically recorded from experiments on various kinds of timber by Prof. R. H. Thurston and his students, at the Stevens Institute of Technology, New York. The exercise is to construct the necessary scales, and read from the diagram the figures for a table of results under the following heads:—

No. of Exp.	Stress: Torsive. Moments in foot lbs.	Strain: Torsion in Degrees.							
		White Pine.	Yellow Pine.		Black spruce	Ash.	Spanish Mahogany.	White Oak.	Hickory.
			Sap-wood.	Heart-wood.					
	?	?	?	?	?	?	?	?	?

Ex. 65, Fig. 77.—Draw a "polar" stress curve from the figures which you obtain in the table for white oak. Degrees to be measured from a protractor. Scale for moments, 10 foot lbs. per inch.

[Draw radial lines, from the pole, corresponding to each entry in degrees, and measure off on each line the moment in foot lbs., which produces that amount of torsion.]

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‡ From experiments by General Uchatius, Abst. Proc. Inst. C.E., xlvi.

LESSONS IN MECHANICAL DRAWING.—XIV.

(*For description see page* 147.)

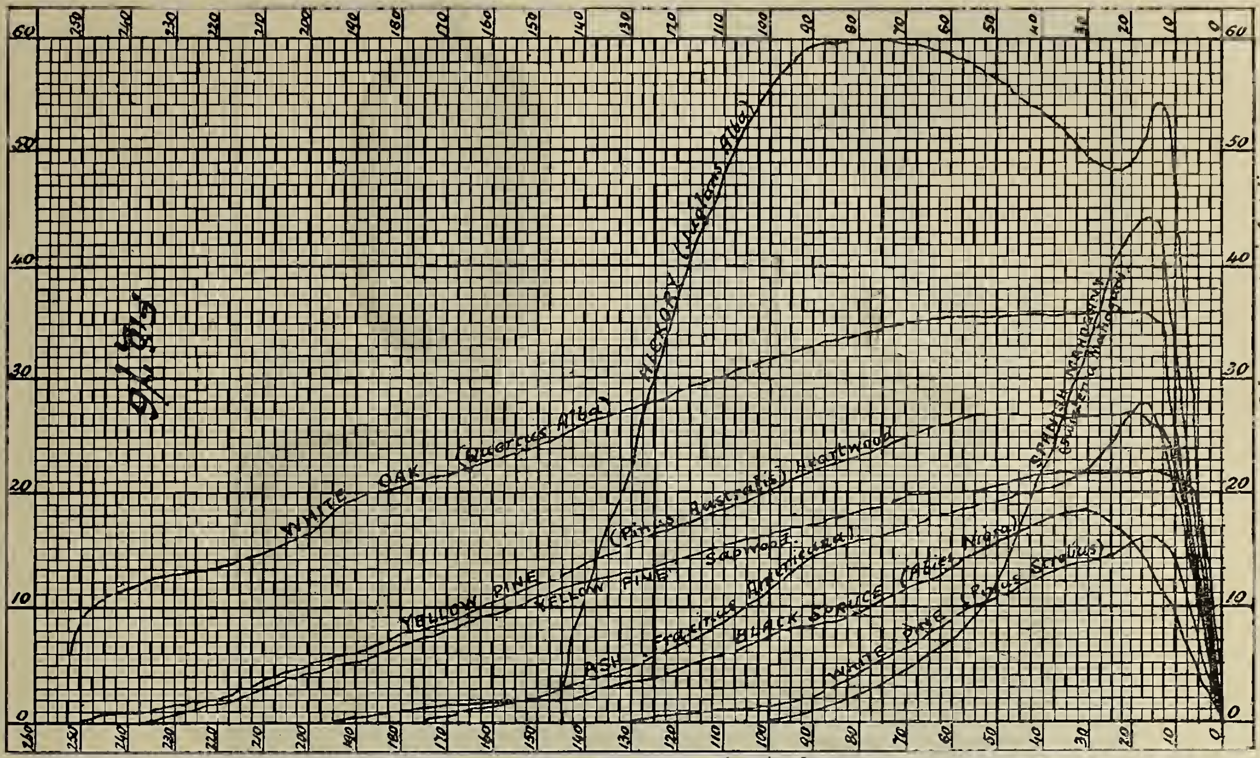


Fig 76

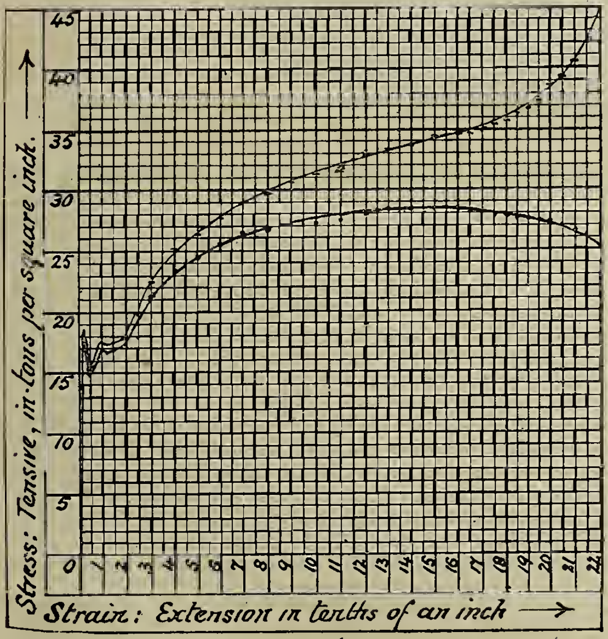


Fig 75

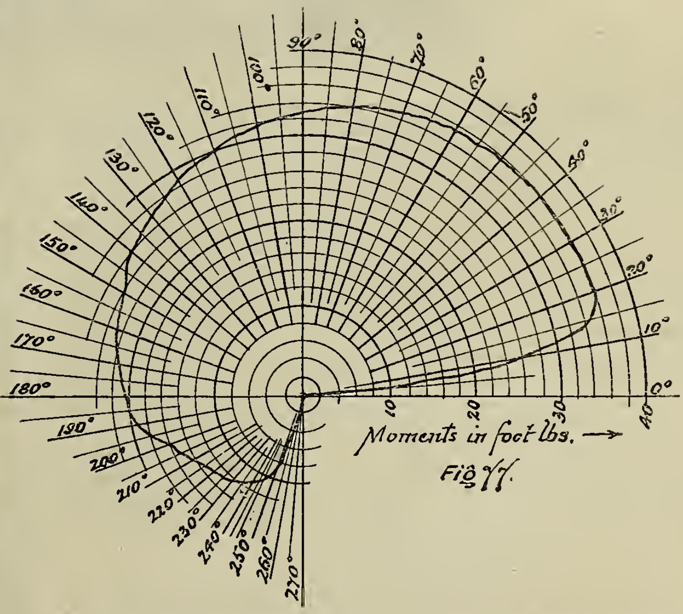


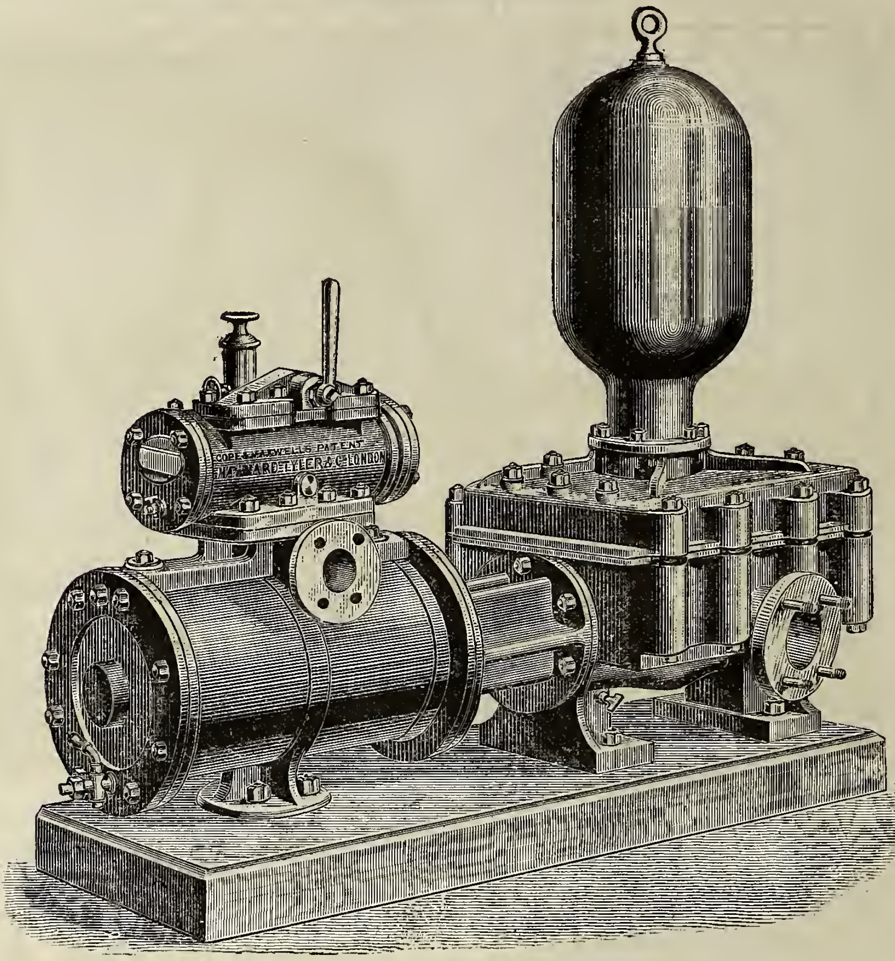
Fig 77

SANITARY ENGINEERING.—The Home Counties District meeting of the Association of Municipal and Sanitary Engineers and Surveyors was held on Saturday week at the Town Hall, Maidstone. Mr. Joseph Gordon, M.Inst.C.E., the president of the association, occupied the chair. Mr. F. J. C. May, C.E., in a paper on the "Sanitary and other improvements within the borough of Maidstone during the last ten years," dealt at length with the question of the disposal of sewage, the granolithic paving, the erection of the infectious hospital, the substitution of granite for Kentish rag in road-making, and also with the proposed improvement at the tanks. These were to be divided into twenty equal-sized compartments, with a narrow channel running down the centre. At many riverside places the acquisition of a sewage farm was deemed necessary for the purification of the liquid sewage, which was filtered through the land before being discharged into the river; but at Maidstone the plan adopted was to separate the solid matter from the effluent water, which was then treated chemically. Hitherto the process had not been successful, complaints being made as to the pollution of the river.

DRY FLOORS.—*Indian Engineering* says that the most effective way to keep the ground floors of dwellings and storehouses dry is, when building, to spread over the spot a layer of fine coal dust stamped compactly. A layer of sand of equal thickness is then laid over it, and upon that the floor. When so constructed, the floor will, it is said, always remain dry from the coal dust absorbing the moisture of the soil. The sand layer, and hence the floor, are secured from dampnes and continue dry.

STEAM-PUMP FIRE ENGINES FOR MILLS.

CONSTRUCTED BY MESSRS. HAYWARD, TYLER, AND CO., LUTON.



The engraving herewith represents a fire engine steam-pump, specially adapted for mill purposes, constructed by Messrs. Hayward, Tyler, and Co., engineers, Luton. In the Lancashire cotton mills, where a fire once started spreads with such extraordinary rapidity, pumps of this class are coming into great favour, and many mills have not only their fire-engine pump, but a special staff of trained men, whose duty it is to operate the hose pipes in case of fire. By this means several mills have been saved from what would undoubtedly have proved disastrous fires if extraneous help only had been depended upon. In the pump illustrated above the valve is moved by the steam without the aid of tappets or auxiliary valves, and a fast or slow stroke can be obtained at pleasure with perfect steam exhaustion at the ends when running at the quickest speeds. The pump valves are on the ball principle; made of indiarubber, and working in gun-metal cages; they are quite silent at the highest speeds and wear out very slowly. One of these pumps at Messrs. J. Ambler and Sons, Luddendenfoot, working at 120lb. water pressure, with 70lb. boiler pressure, discharges four ¾in. jets four storeys high, and is giving entire satisfaction.

THE INSTITUTION OF NAVAL ARCHITECTS.

On Wednesday week, at the Society of Arts, Adelphi, the three days' annual session of this institution was opened under the presidency of Lord Ravensworth. There was a large company present, including the representatives of the Royal Navy and mercantile marine, as well as naval architects of both national and private shipbuilding yards. An invitation had been received from the President of the Institution of Engineers and Shipbuilders of Scotland, the Clyde Steamship Owners' Association, and the Sailing Ship Association, which had been accepted, and the meeting would be held in July.

The President, in moving the adoption of the report, said it was most fitting that this year's meeting should be held in Scotland, as this was the centenary of steam navigation, the first steamer having been set afloat in 1788 in Scotland. He rejoiced to say that there had been a moderate improvement in our national industries, and that the great shipbuilding industry was sharing in that improvement. Apprehensions had been expressed as to the effect of increased tonnage upon freights, but he trusted that those apprehensions would be found to be unjustified by events, and that by an assured peace throughout the world there would come a general prosperity. His lordship then dealt with the question of the national defence, and referred to the views which had been expressed by experts as to the necessity of defending our mercantile ports and commercial centres, and to the votes which had been proposed to meet this defence. He referred to the steps which had been taken by the Government in providing for four new types of vessel, in the work of maintaining our maritime supremacy, and praised the prevision which had ordered these new types, first—of armed cruisers of great speed, then of a torpedo ship of a cruiser class, then of a powerful sloop and a class of torpedo gunboats.

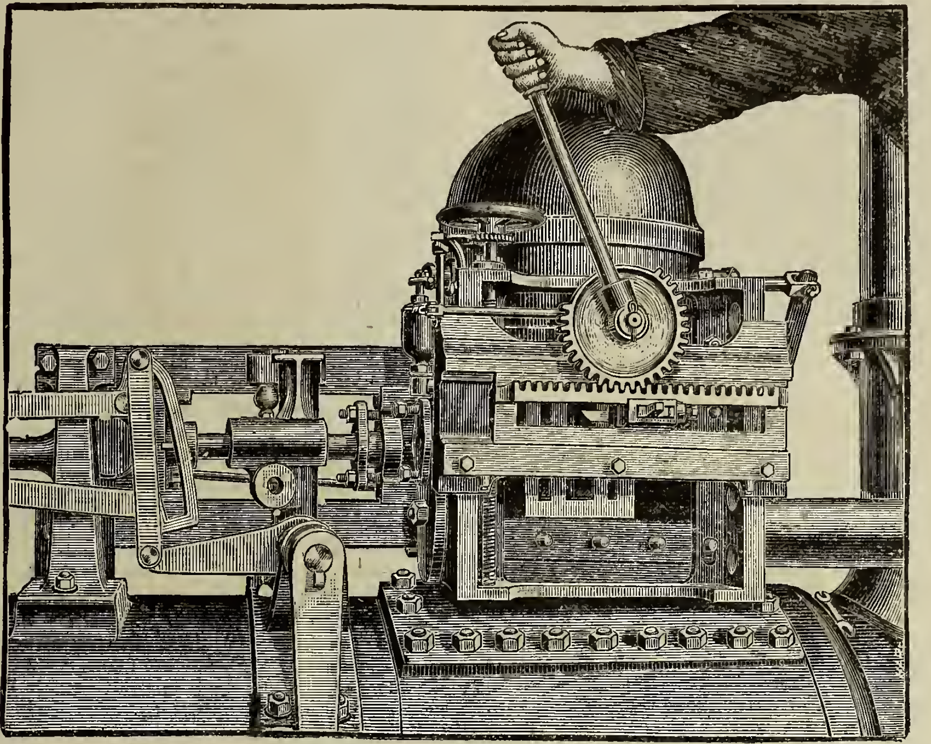
The papers first read all had relation to war ships. The first was by Mr. W. John, a member of the council, on "American Warship Design;" the second was by Captain C. C. Penrose Fitzgerald, R.N., on the subject of "Unarmoured Water Lines in Ships;" the third being by Captain Hubert Grenfell, R.N., on "The Development of Modern Weapons Considered in Relation to the Designs of War Ships."

Mr. John's paper, which was read by its author, was illustrated by large diagrams, and had relation to a design which the American Government had selected in an open competition. Mr. John commenced by saying that the United States Government had not, since their great war, gone to any length in building up an ironclad fleet such as was possessed by this country, France, Italy, and Germany; but there had been signs within the last few years of the desire to make a start in this direction, for the American Government had bought designs from private firms in this

[*Continued on page 152.*]

MACHINE FOR PLANING-UP SLIDE-VALVE FACES.

CONSTRUCTED BY MESSRS. F. ALLCHIN, LINNELL, AND CO., NORTHAMPTON.



All steam users know more or less the great difficulty in keeping true the slide-valve face of their steam engines, and this difficulty becomes all the more serious when they are far removed from engineering shops able to reface these slide surfaces. Even in the most favourable cases the temporary stoppage of the steam motor until its repair has been effected is a vexatious item; but as the keeping of the slide-valve face true is one of the most essential points in the good working of any engine, the need of a handy machine that should perform this work, without having first to dismantle the cylinder from the engine, at once becomes apparent. The machine for planing-up slide-valve faces, which we illustrate in the accompanying figure, has been specially designed to do this job, and our engraving is supposed to show this machine in working order on a traction engine. The present general plan, when the valve port face is cut, is to remove the cylinder from the engine, and to take it to the planing machine in a shop, which plan entails both time and expense. With the machine here illustrated, the slide-valve face can be planed up true in about three hours' time, by simply removing the steam-chest cover and bolting the machine on in its place. Regulator seats may be faced up with equal ease and accuracy. The planing tool is fixed to a carrier slide, which is motioned to and fro by rack and pinion gear, the pinion being oscillated by the hand lever shown. The tool slide is furnished with transverse motion to regulate depth and position of cut, and this motion is obtained by a hand wheel and ratchet working a suitably threaded spindle. It has been designed by Messrs. F. Allchin, Linnell, and Co., of Weston Street Works, Northampton, and must be admitted to be exceedingly simple and expeditious in its working, especially for portable and traction engines mostly working in agricultural districts, more or less removed from engineering shops.

A Novel American Locomotive.—A locomotive possessing several unusual features has been recently built by the Hinckley Locomotive Company, of Boston, for the Swinerton Locomotive Driving Wheel Company. The engine is designed to run fast passenger trains, and has a single pair of drivers, 67in. in diameter on tread, and a pair of 42in. trailing wheels with radial motion. The front end of the engine is carried on a four-wheel truck, as usual. The engine has piston valves, but the most novel feature is the form of the tread of the driving-wheels. The circumference of the tyre, instead of being a true circle, is polygonal, and formed of 105 flats, each about 2in. long. The object is alleged to be to prevent slipping! The engine has, we believe, not yet been tried.—*Engineering.*

STATIONARY ENGINES AT THE MANCHESTER EXHIBITION.*

(Continued from page 141.)

Messrs. Mather and Platt showed a pair of vertical inverted cylinder engines—cylinders 20in., and 30in. stroke—which, running well, and of substantial design, appeared amidst their horizontal confreres to be almost a challenge, and in some degree to re-open the question of horizontal or vertical engines for land purposes. Noticeable features of these engines were the flywheel pulleys. On each of these ran two link belts, for which the pulleys were double-curved: the links of the belts were made deeper at the edges than at the centre in each case, so avoiding the bending of the link pin which would otherwise occur.

Besides the engines referred to, there were several others in the electric light shed, perhaps the best of which were the engines by Messrs. Roby, fitted with the Proell cut-off gear. Generally, however, the engines in this department were clumsy in valve gear, and all had both top and bottom slide bars, whilst their defects of form were in most cases attempted to be hidden by a liberal use of the coachbuilder's line style of painting. The double slide bar was, I was informed, almost universally used by these eastern makers, because the engines were made for stock, and I suppose that in one case in ten it is possible that the engine might have to run in a left-handed way. On one engine especially, the top bored slide bar, cast in one with the bed, boxed up the piston rod, connecting rod end, and gland in a way that would suggest that these parts were too modest to come out under the full glare of the electric light.

After this rough general description, which will perhaps serve to recall some of the more noticeable points of the engines referred to, it will perhaps be useful to compare some of the main features in the design of the different engines. It is very noticeable, as bearing on the point of the best valve, that the four principal engines were all fitted with valves of the Corliss type; the whole of the valves of Messrs. Adamson's and Wood's engines being below the cylinders, while in Musgrave's and Hick's engines the steam valves were above and the exhaust valves were below. The latter arrangement, I believe, has given the best results in practical working, the separate valves being much more easily kept in order than the somewhat complicated arrangement which is necessitated by all the valves being below the cylinder; the latter arrangement, however, has a taking appearance of neatness. All these engines, except Messrs. Adamson's, had separate eccentrics to actuate the steam and the exhaust valves. Here, again, it must be observed that the apparent neatness of the single eccentric arrangement of Messrs. Adamson's engine is neutralised by the fact that, with only one eccentric to both the steam and exhaust, the limits of adjustment are greatly narrowed.

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* Paper read before the Owens College Engineering Society, February 7th, 1888, by Mr. E. G. Hiller, Assoc. Owens Coll.

What would doubtless be a novelty to many was the Knowles' supplementary governor on Messrs. Hick's engine. In this arrangement the rising or falling of the supplementary governor brings the top or bottom of the governor muff in contact with a wheel, which, thus caused to rotate, acts through a geared arrangement, and lengthens or shortens the rod to the other governor. It will be noted that between the speeds at which the top or bottom of the supplementary governor muff touches the wheel the engine is governed in the ordinary way by the other governor. The combined action of these governors produces a very steady arrangement. If a given variation of speed may be allowed without detriment, the governor may be arranged to run with the supplementary governor action alone, as was done with Yates's engine, the governing in that case being wholly done by the smooth bevel wheels of the governor muff, the contact of the upper or lower of these with the single bevel wheel causing the cut-off cams to be put forward or back, and so controlling the speed. The comparatively light style of these governors may be usefully compared with the very heavy governors to be found on some of the electric-light engines. In several of these engines the control of the governor on the engine was exercised by the raising or lowering of a block in link—the arrangement known, I believe, as "Fink's" link. The governors in this case had to overcome the friction of the block on the link, and hence the necessity for great power. The arrangement, however, is unsuited to great accuracy of speed, and is clumsy; very often cut-off gears of this link type may be seen driving their governors—that is, causing the governor to rise or fall according to the inclination of the link. Now, to come to what was perhaps the most striking point of difference in these engines—the beds.

The straight-line type with the top and bottom slide bar, as in Messrs. Adamson's and Hick's engines, is a cheap form, and also gives the impression of there being no bending strains, such as take place in beds like those of the other engines shown in the sketch. It will, however, be seen that the absence of bending strain is only apparent—the centre line of the connecting rod being outside the bed. The top slides of these engines are, I suppose, intended partly for appearance, and partly to stiffen the bed—this form of bed looks very neat—and I believe the foregoing are the principal advantages of this type. On the other hand, with an engine running in the usual way, the top slide bar is useless, and causes a boxed-up arrangement of crosshead. The beds with bottom slides only, like Messrs. Musgrave's, Wood's, and Yates', give much greater accessibility and freedom of adjustment to the parts. On the whole, for large engines, perhaps the bed of Messrs. Musgrave shows the greater suitability, as although it was apparently clumsy and stuck together, yet it was evident that accessibility and convenience of adjustment had received great consideration. The vertical engine of Messrs. Mather and Platt in some way seemed to ask the question, "Why are horizontal engines used instead of vertical for stationary purposes?"

In the vertical engine the cylinder wear is comparatively small and uniform, whilst in the horizontal type the weight of the ordinary form of piston usually causes the cylinder to wear oval, and to need re-boring, sometimes after only two or three years' work, or less. The vertical engine occupies less space, but on the other hand the various parts are less accessible than in the horizontal; and as I think that it is this point of accessibility and convenience that has so far decided the question of horizontal or vertical engines, you will no doubt excuse the somewhat prominent position which I have given to accessibility in these few remarks.

I might sum up by saying that although the engines exhibited were all of fairly good types, yet none of them were faultless, and all showed points in which improvement was possible. I think it should not pass unnoticed that the most popular type of modern mill engine—the horizontal tandem compound engine—was conspicuous by its absence. This, however, may have been due to considerations of space and floor room.

In conclusion, I would apologise for the superficial consideration of many very interesting points, and can only excuse myself by pointing out that many of the details referred to—governors, beds, valve gear, cylinders, &c.—would each in itself more than supply material for an evening's consideration, rather than the few minutes to which to-night we are limited.

THE INSTITUTION OF NAVAL ARCHITECTS.

[*Continued from page 150.*]

country, and in 1886 issued an advertisment to "naval architects and others" concerning steel-armoured vessels for the United States navy, and the prize of $15,000 was offered for each successful design. Two designs he entered upon were completed in six weeks, and the battle-ship design was accepted and awarded the prize. The paper gave details of the design, and discussed the fighting qualities of the vessel which would thus be possessed by the United States.

It was decided that the other papers should be read before the discussion, and Captain Fitzgerald then read his paper, which discussed the comparative chances of one of our modern battleships being sunk through the infliction of a number of small wounds in the region of the water line, as against the chances of her being sunk either by a torpedo, a blow from a ram, or through the injury produced by projectiles of modern warfare. He discussed the theories of modern naval construction, and drew attention to the use which the French were making of cellulose, said to be a preparation of cocoanut fibre, for the protection of water lines of iron or steel built warships. He dealt with experiments which had been made with indiarubber in this country in this connection, and urged the necessity of experiments on this matter. He concluded by saying that it was, he believed, admitted to be impossible to encumber our already overloaded citadel ships with any additional armour for the purpose of protecting their exposed ends from the destructive effect of rapid-firing guns of small calibre; but there they were, designed against one gun fiend and forthwith attacked by another. We had a great many of them in this country, in fact they formed the backbone of our present navy, and if his assumption as to the effect of quick-firing guns was correct, or even partially correct, we were face to face with a very serious problem, one demanding the most earnest attention of our naval architects—one which, left unsolved, might mean nothing less than national disaster.

Captain Grenfell discussed at great length the subject of the general progress which had been made in the development of the weapons of naval warfare in relation to the designs of warships.

A discussion followed, and the meeting was adjourned.

The annual dinner of the institution was held the same evening at the Holborn Restaurant. Lord Ravensworth presided.

The members met again on Thursday, when the first paper read was by Mr. Richard Sennett, R.N., on the "Working and Test Pressures for Marine Boilers." After pointing out the importance of the questions relating to the strength of boilers, of the *maximum* working pressures of steam which could safely be carried in marine boilers of ordinary form with plates of workable thickness, he discussed the subject of the "factor of safety" in the working steam pressures allowed to be carried with a given thickness of plate. He stated that the factor of safety, as usually employed, was a somewhat rough and ready method of alllowing for stresses, strains, and conditions which could neither be exactly calculated nor ascertained. In other words, the "factor of safety" was, to a great extent, an allowance for want of knowledge; for as the marine boilers formerly contained many unknown qualities, such as material far from uniform in strength and quality, and the arrangement of seams was left in the hands of foremen, high factors of safety were justifiable, but the necessity for large factors of safety no longer existed, since with the introduction of high steam pressure and steel plates much greater attention was paid to the materials and workmanship, and the ordinary mechanical rules could be applied to boilers. He pointed out that in 1877 the ordinary working pressure was from 60lb. to 70lb. per square inch, and under the then rules further progress was barred in consequence of the required thickness of steel plates. But these rules were modified, with the result that working steam pressures of 140lb. to 150lb. per square inch were now general in marine boilers. He discussed the present rules of the Admiralty, Lloyd's, and the Board of Trade, and said he regarded the traditional hydraulic test pressure for boilers of double the working steam pressure as a retarding influence; it had now been given up by the Admiralty as unnecessary. He held that there was no reason to doubt that the regulations adopted by the Admiralty for the boilers of Her Majesty's ships could be adopted with much advantage for all marine boilers.

The paper occasioned much discussion, and the views of Mr. Sennett were controverted by some of the speakers, who included Professor Kennedy, Mr. Daniel Adamson, Mr. F. C. Marshall, and Mr. Kirk.

In answer to a specific question put to Mr. D. Adamson as to whether he agreed with the Admiralty regulations, he said he held that the test pressure ought to be fixed according to the working pressure.

Mr. **Parker** (Lloyd's) considered that the lessening of the factor of safety would be dangerous, and dealt with the uncertainty of metals and other elements of danger. In joints of metal the strength was altogether theoretical, and he contended that, considering the accumulation of pressure in marine boilers at times, and the loss by corrosion in the metal, it was necessary to have large reserves of power in the boilers. He quoted the views of locomotive engineers, to the effect that the theoretical strength of boilers should be six times the working pressure. Thus the rules of Lloyd's were justified by experienced men.

Admiral **De Horsey** protested against the saving of weights in men-of-war by adopting a *minimum* of pressure.

Mr. A. F. **Yarrow** presented a paper "On the Possible Advantage of Using Highly Volatile Liquids in lieu of Water for the Purposes of Propulsion." He described a launch, which weighed only a ton, propelled by means of a highly volatile hydro-carbon. The propelling machinery was placed at the stern, and consisted of an ordinary direct-acting invert engine. The vapour generator was placed immediately aft of the engine, and consisted of a copper coil enclosed in a double sheet-iron casing, the intermediate space between these casings being filled with asbestos. Below the coil was an iron pipe, bent into the form of a ring, perforated with holes, and arranged as in a Bunser burner, so that a mixture of hydro-carbon and air could be forced into it and ignited on issuing through the holes. The hydro-carbon was in the bow compartment, and of a capacity of 40 gallons, and was in communication with the feed pumps of the generator by a pipe passing outside the boat close to the keel. After the start the working was automatic. The working pressure of 70lb. per square inch could easily be maintained, and the boat could run from seven to eight miles an hour for several hours. The use of the hydro-carbon (one of the earliest products of petroleum) permitted the start of the launch at full speed in not more than five minutes from the lighting up. It also allowed the whole of the central part of the boat to be available for passengers. There was a saving of weight of machinery, and the whole arrangement was very cleanly.

Papers were presented by Mons. J. A. **Normand** and Mr. A. **Blechynden**, the first on "The Fineness of Vessels in Relation to Size and Speed," and the second "On a Method of Approximately Determining the Mean Girth of a Ship."

At the evening meeting, at which there was a very large attendance, a paper "On Forced Draught" was read by Mr. J. R. **Fothergill**, and another on "Boilers under Forced Draught on the Closed Stokehold System," by Mr. **Thomas Soper**, R.N.

The third and last day's meetings were held on Friday, in the afternoon and evening.

Mr. R. E. **Froude**, chief of the Admiralty Experimental Works, Portsmouth, read a paper on the "constant" system of notation of results of experiments on models used at the Admiralty Experimental Works. He stated that a large portion of the work carried out at the Admiralty Experimental Works consisted in ascertaining, for a variety of speeds, and generally for three different draughts and fore and aft trims, the resistances of models of designs for particular ships about to be built. The results were communicated to the Admiralty in the form of curves of E.H.P. calculated from the model resistances, for the intended ships represented by the models. He stated that the utility of such experiments was not limited in their application to the particular ships represented by the models experimented upon. Each such model, and each draught of each model, equally represented an indefinite number of imaginary different ships of any variety of absolute sizes, of which some one or more would frequently be found available to sufficiently represent possible alternatives to any new design in contemplation.

Professor A. G. **Greenhill** read a paper on "A Theory of the Screw Propeller," a contribution which raised questions, in the form of mathematical formulæ, as to the action of the screw propeller in work, a subject which has been dealt with from different points of view by different authorities. The paper was wholly technical. Of a like character was a paper by M. J. B. **Andreæ**, on the results of experiments with four and two bladed screw propellers.

The papers before the evening meeting were by Lieutenant W. **Hovgaard**, of the Royal Danish Navy (on proposed designs for surface boats and diving boats), by Mr. W. **Wallace** (on the material best suited for propeller blades), and by Mr. J. H. **Heck** (notes on the influence of size and speed on collisions at sea).

CORRESPONDENCE.

We do not hold ourselves responsible for the opinions of our Correspondents.

TEST AND WORKING PRESSURES FOR MARINE BOILERS.

To the Editor of "The Practical Engineer."

Sir,—A paper having the above title, remarkable alike for its hasty and dangerous suggestions, was read by Mr. Sennett, Chief Engineer of the Navy, at the recent meeting of the Institute of Naval Architects, and, looking to the position of its author, it is of national importance that, if he is in error, he should be corrected and restrained from acting upon his ideas. Dependent as we would be in time of need on our vessels of war, it is of paramount importance that there should be absolutely no doubt as to the sufficiency and efficiency of their boilers and machinery, as the failure of either would, undoubtedly, result in the destruction of the vessel by the enemy. The rule given for the construction of boiler shells by Mr. Sennett, when put into formula shape, is—

$$p = \frac{f\,c\,t}{1\frac{1}{8}\,\mathrm{D}} - 90$$

where p = working pressure in lb. per sq. in.
f = ultimate tensile resistance of the material in lb. per sq. in.
t = thickness in inches.
D = mean diameter of boiler in inches.

Let us examine the effect of the rule in certain cases. It is plain that no working pressure would be allowed for a boiler when—

$$\frac{f\,c\,t}{1\frac{1}{8}\mathrm{D}} = 90$$

that is, when the calculated pressure which this shell would withstand is $90 \times 2\frac{1}{4} = 202\frac{1}{2}$lb. per square inch.

Again, if we take a boiler of a certain thickness, and compare it with one of double the thickness, both having the same pressure by the rule, it would seem, *cœteris paribus*, that the margin of 90lb. would represent a thickness for corrosion, &c., twice as great where the thick plates are employed as in the other case, since the ultimate resistances of the boilers vary in that proportion. It would, however, serve no useful purpose to take up more of your valuable space to illustrate the absurdity of the results obtained from the rule in question, but it is rather to its mischievous character that I would direct attention.

It is admitted in the paper that it may become dangerous if the pressure within the boiler is allowed to much exceed $(p + 90)$ or that which would subject the boiler-joints to their proof stress, yet with large pressures, of which our experience has not extended over many years, we are to approach uncomfortably near this critical point, for

$$\frac{90}{2\frac{1}{4}(90 + p)}$$

becomes relatively small as p is increased, and the expression implies that, with very high pressures, we are to be content with a factor of safety but little exceeding $2\frac{1}{4}$. Has anyone had the temerity to propose this, even in the design of structures subject to a known *dead* load? Is it not alarming to be told that naval boiler shells, 12ft. in diameter, have actually been constructed in accordance with this rule, for a working pressure of 155lb. per square inch; that, in fact, the shells, when *new*, only possessed a factor of safety of about $3\frac{1}{2}$ to cover contingencies which, with the best workmanship, may not be avoided, and the nature of which are not even known. The fact is, sir, that *old* boilers in the mercantile marine, which did not possess a greater factor than this, would unhesitatingly be condemned and taken out of the vessel, yet our men-of-war are to be furnished with *new* boiler shells which have no greater margin of safety.

The following table illustrates the effect of these rules:—

Internal pressure per square inch which would correspond with			Working pressure which would allow a factor of safety = 5.
Ultimate stress on joint.	Proof stress on joint.	Working pressure.	
877	390	300	175·4
652	290	200	130·4
540	240	150	108
427	190	100	85·4
371	165	75	74·2
315	140	50	63·
258	115	25	51·6
202	90	0	40·4

Are the results in column 3 consistent with each other, or would those who would take advantage of the rule in the case of high pressures be content with its application where the desired working pressure is much below 70lb. per square inch?

It is much to be regretted—especially, I think, by its author—that the paper was read. Forgetting the generality of its title, it was, at the meeting, at last asserted that there was a great difference between the requirements of the navy and those of the mercantile marine in the matter of boilers; but, though strong efforts were made by its friends to defend the existing Admiralty practice, they were unsuccessful. "Limitation of weight" appears to give the motive to reduce the scantlings of naval boilers, steam-pipes, and engines, to such an extent that the many breakdowns of which we hear do not surprise us.

Not long ago, H.M.S. Wasp disappeared—how, nobody knows. It would be interesting to know if her boiler shells were subjected to so great a stress as those of the "Medea," as the giving way of a boiler shell would certainly result in the destruction of the ship and the loss of all on board.

It is a grave matter, in which both life and money are greatly concerned, and, since such views are promulgated by the head of the Admiralty engineering staff, it can hardly rest where it now is.

March 26th. X. I. X.

BRAKE TO PREVENT OVERWINDING.

To the Editor of "The Practical Engineer."

Sir,—Being closely connected with the work of the much neglected winding engineman, I cannot refrain from speaking when I read "Mining Engineer's" theoretical description of his automatic brake in your issue of the 2nd inst. In short, it displays what he ought to have kept quiet. Did it ever occur to him that when the cage had reached the point which it ought not to have reached when under proper control that it was already overwound? How he can prevent that which has already happened I cannot tell, be his brake ever so automatic. An automatic arrangement for stopping the engine, and consequently the cage, in case of sudden illness, may be useful; but I say give a winding man a properly-balanced engine, with easily workable convenient valve gear, and a powerful brake (not automatic), and the cases of overwinding will be few and far between. A Practical Engineer.

TALLOW CUPS v. SIGHT-FEED LUBRICATORS.

To the Editor of "The Practical Engineer."

Sir,—In my previous letter on the above subject, contained in your paper of the 24th ult., I pointed out why I consider the sight-feed lubricators placed upon the main steam pipe of a steam engine to be necessarily wasteful of the lubricant used, and contended that the ordinary tallow cup, with its periodical flushings of the lubricant directly on the surfaces to be lubricated, is, with proper care and attention, a better method of lubricating than the homœpathic method of lubricating drop by drop. As an illustration, I instanced a modern engine with four cylinders, passing 272 cubic feet of steam every second, and suggested the reflection that with two or three drops of the lubricant vaporised and mixed with such a large quantity of steam, what little effect it must have in greasing the valves and pistons. Since writing I have timed one of the large-sized sight-feed lubricators, and instead of discharging two to three drops per second, it only delivered eight drops per minute. It struck me that it could not use a large quantity at that rate, and I asked the engineer if that was all the lubricator he had. He at once pointed to an ordinary tallow cup on each of the five cylinders, saying he could not depend upon the sight-feed alone. In your impression of the 2nd inst. there is a good practical letter, signed "Sight-feed," in which he says he lubricates four cylinders—two 27in. and two 37½in. diameter respectively, making 37½ strokes per minute—with half a gallon of oil for ten hours, which is a little over 1lb. per cylinder. Without disputing the correctness of his statement, if it includes the whole of the oil used in the cylinders, I must say it is much below any consumption I have come across with these lubricators. But I contend, sir, that whatever quantity of lubricant is found sufficient when injected into the steam pipe and mixed with the steam, a less quantity would be sufficient if discharged directly on the rubbing surfaces, whether by periodical flushings or drop by drop through the sight-feed lubricator. When the steam is saturated with grease a considerable quantity must necessarily be carried away in the steam and wasted.

I have no fault to find with the new lubricator, providing it is placed on the side or lid of the cylinder or valve box, where each drop will be delivered directly on the piston or slide valve and distributed throughout the rubbing surfaces by capillary attraction. But even in that case it is a question with me whether a better result would not be obtained by a proportionately larger quantity given intermittently at short intervals, so that the pores or interstices of the two opposing metals may be better charged or saturated with the lubricant. In the case of a horizontal engine, with the slide valves on the side of the cylinder, and which are often difficult to lubricate, I think the lubricant ought to be conveyed by a pipe connected to the lubricator and to the top side of the valve facing, and delivered through one or two perforations therein, directly under the slide valve, as is done in the case of large footsteps. By delivering the lubricant directly on the rubbing surfaces there is none carried away in the steam without first doing its duty, as must certainly be the case when it is vaporised and mixed with the steam before it enters the valve box or cylinder.

If some enterprising maker would direct his ingenuity towards inventing an intermittent motion, which would deliver a certain quantity of lubricant at regular intervals of, say, one hour or less, it would obviate the abuse of irregular intervals and excessive quantities, to which I admit the old tallow cup is liable, and it would be the means of greatly reducing what is now a heavy charge in the working of steam engines generally.

I am glad that your paper is now finding its way into the engine-house, and being read and contributed to by the working engineers of the country, to whom, and their employers, the discussion of such questions as this must be of interest and profit, more especially to such persons as your correspondent, "Eureka," who says he has about 100 engines under his control.—Yours respectfully, Artizo.

Oldham, March 20th, 1888.

POLLITT AND WIGZELL'S ENGINES.

To the Editor of "The Practical Engineer."

Sir,—As there seems a desire to see the diagrams, I have sent you two sets; one taken before the application of an automatic expansion gear, and the other after. The high-pressure cylinder is 15in. diameter, low-pressure 27in.; stroke, 4ft. 6in.; revolutions, 88 per minute. Fig. 1 shows the figures before alteration. The average pressure in small cylinder is 26·1lb., and in large cylinder 6·57lb., and the horse powers 110·6 and 90 respectively, or a total of 200·6 h.p. Boiler pressure, 68lb. Fig. 2 represents the diagrams after alterations. Average pressure in small cylinder, 30·21lb.; indicated horse, 128. Average pressure in large cylinder, 5·5lb.; indicated horse, 75·3; total h.p., 203·3. Boiler pressure, 67lb. After alteration the initial pressure rose to within 4lb. at one end and 6lb. at the other of the boiler pressure, while before alteration it was 25lb. short. The exhaust is also effected at a reduced pressure, and the vacuum is improved.—Yours, &c., J. W .J

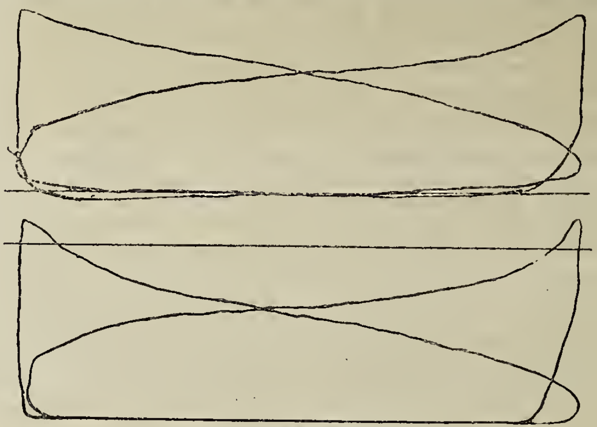


Fig. 1. Before Alteration.

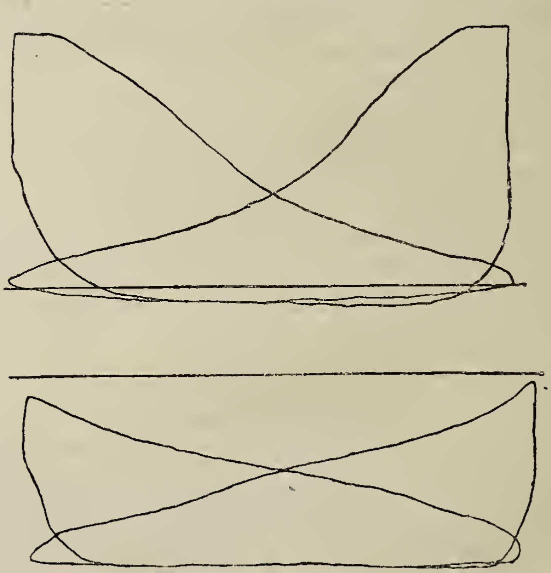
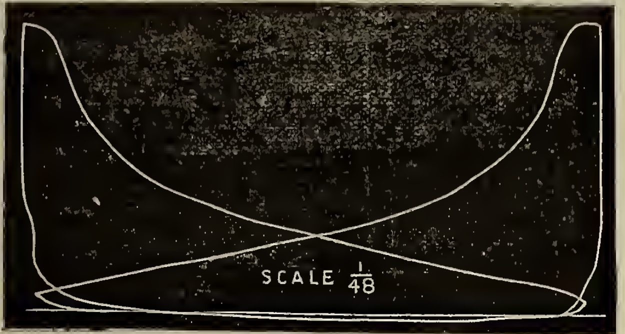


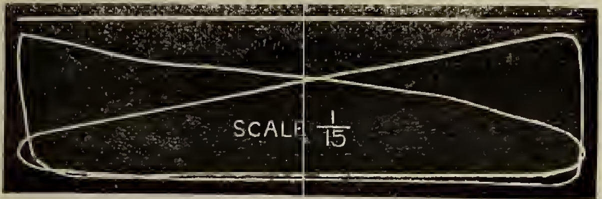
Fig. 2. After Alteration.

To the Editor of "The Practical Engineer."

Sir,—I fail to see how the low-pressure piston-rod passing through the high-pressure ports can have any effect on the initial pressure if the ports are made of the proper dimensions. I have at present charge of one of the above engines, and can any time get within 3lb. of the boiler pressure on to the high-pressure piston with a piston speed of 781ft.

per minute. And as for "J. H." saying that P. and W.'s engines will never break down because very little pressure can be got on the piston, this simply tells us that his experience with this class of engine is very limited indeed, as I know there are some of these engines working at the present time with over 30lb. more pressure on the piston than have the engines he has charge of, and have been working for several years without a break down. I enclose diagrams of our tandem engine. The high-pressure cylinder is 22in. diameter, low-pressure 38in., stroke 56in., revolutions per minute 71, boiler pressure 74lb.





JOSEPH BEAUMONT, Engineer, Gomersal.

March 26th, 1888.

BOILER REGISTRY AND INSPECTION BILL.

To the Editor of "The Practical Engineer."

SIR,—Will you please find room in your useful paper for a few remarks on the agitation got up by "Public Interest"? Being a constant reader of *The Practical Engineer*, I have been waiting to see if any of your readers would give us any idea what they think an engineer and stoker ought to be able to pass, providing this bill should come into force. I see one writer says that no matter how good and well tested a steam boiler or a steam engine may be, accidents to boilers and machinery will take place so long as the men in charge are not put to some qualifying test; but I wonder if he thinks that those men have never had a mishap. I believe, like our friend A. Mosley, that the practical man should be before the theoretical man. I think if some independent firm would make boilers with the same care and attention to material and workmanship as is done in making steam engines, that they would command a trade, although their prices would necessarily be higher than those who make them in the ordinary way. Boilers thus carefully built would be much cheaper in the end, to say nothing of the greater safety to life, the loss of which cannot be compensated for; and this, to the humane, is a consideration of importance; and, I might say, that whatever may be the strength of boiler plates before they are worked into shape, if care and attention are not paid to the bending, punching, drifting, and riveting, the best iron will become comparatively valueless. With the best material, the strength of a boiler must greatly depend upon the manner in which it is made and the care used in its construction, even if its form be correct in principle; therefore I say, instead of enginemen having to pass an examination, it would be better for the Board of Trade to inspect boilers before the latter are turned out of the shops, and several times during their construction.—Yours truly,

W. M. H.

QUERIES AND REPLIES.

RAMSBOTTOM PISTON RINGS.—Will some reader give me a little information on expanding Ramsbottom piston rings, steel and cast iron, for cylinders 12in., 16in., and 20in. diameter, varying from ⅜in. to ⅝in. wide, and ¼in. to ½in. thick?—A. J.

Answer.—The ring of metal from which the rings are cut has feet cast on it. These feet are bolted on to the face-plate of the lathe, thus holding the work firmly, and avoiding any strain there would be if the ring were held by the jaws of a chuck. The ring is then rough-turned, in and out, and afterwards cut off and slotted, and then finished in the lathe. Turn them about ¼in. per foot larger than the cylinder diameter. The slot may either be straight across or at an angle. If straight across, the ends should be open about $\frac{1}{32}$in. when in cylinder. Use two or three rings, and see that they break joint. These remarks apply to cast-iron rings.—A. R.

Answer.—Hold the ring on a hard smooth surface, and strike lightly round its inner circumference with the round nose of a hammer. Enough force must be used to cause the inner side of the ring to expand, turning it slowly round when striking, so that each part may be equally expanded.—PISTON.

PRIMING.—What are the chief causes of priming in marine boilers, and the remedy for same? I should like to be favoured with the construction of the hydrometer or salt gauge.—ANTI-PRIMER.

Answer.—The chief cause of priming is defective design of boiler, the steam space being too small, or the opening into the steam pipe being too near the surface of the water. The only satisfactory remedy is the addition of a steam receiver to the boiler. Perforated plates may suffice in some cases, as stated by "R. L. F." With priming boilers the water should be kept as low in the glass as possible. But though tallow may keep down priming, it tends to burn the plates, and is now discountenanced by the best engineers. The most simple salinometer is a hollow bulb, with a graduated stem, weighted so as to float upright. Water is drawn from the boiler, the salinometer put to float in it, and according to its depth in the water so is the saltness in the boiler. Almost any book on marine engines will tell how a rough-and-ready one may be made.—C.

TURBINES.—Will you or any of your readers kindly inform me what quantity of water per min. is required to drive a turbine of 6 i.h.p. with 6ft. to 9ft. of fall; also the diam. and speed of the turbine?—W. W.

Answer.—The following is the formula required:—

h = Head of water in feet.
Q = Quantity of water in cubic feet per second.
P = Horse power.
D = Internal diameter of turbine in feet.
E = External diameter of turbine in feet.
V = Velocity of turbine at periphery in feet per second.

$$\text{Then } Q = 12{\cdot}67\,\frac{P}{h} \qquad D = \sqrt{\frac{1{\cdot}77\,Q}{\sqrt{h}}} \qquad E = 1{\cdot}4\,D$$

$$V = 6{\cdot}6\,\sqrt{h}.$$

COPYIST.

BRIGHT WORK.—What is the best thing to put on bright work, after polishing, to keep coke oven sulphur off? I use tallow, but it gets through that the next day.—ENGINE.

Answer.—Copal varnish keeps bright work clean, but other varnish might do as well. Lay it on with a brush over the bright work. It would be of interest if your correspondent would state the result in *The Practical Engineer.*—ASSISTANT.

STRESS ON A ROPE.—Will any reader assist me to calculate the stress on a steel rope 4in. circumference, working on an engine bank, dipping 1½in. in 12 inches. Load 14 tons.—STUDENT.

Answer.—The stress may be found thus: The bank dips 1 in 8. Calculate the hypothenuse of the right-angled triangle thus: $\sqrt{1^2+8^2}=8{\cdot}07$. Then $\frac{14}{8{\cdot}07}=1{\cdot}73$=strain on rope in tons (neglecting friction). Add $\frac{1}{200}$ of 14 tons for friction. This will not be far out for the case given. The stress then becomes 1·8 tons. The safe working load on a steel rope 4in. circumference will be found from tables to be about 6½ tons.—PIT.

ENGINEERING JOURNAL.—I shall be glad to know the nature of the contents of "Der Machinen Constructeur;" also how often it appears, the price, and where it is to be got?—SUBSCRIBER.

Answer.—The journal appears monthly. It is devoted to mechanical engineering matters, and well illustrated. The agents are Verlag von Baumgärtner's Buchhandlung, Leipsic; the price I do not know.—H.

Could any reader inform me how I am to make the following: I want some aluminium tubes about 1½in. diameter, $\frac{1}{16}$in. thick, and about 1½in. long, with flanges on the end. Can I buy the tubes ready made and solder the flanges on, or should I have to get sheet metal, and bend it over, and solder it up all along to make them? What would be the best kind of solder? Is aluminium very expensive, and who manufactures it?—W. Ll. P. W.

ILLUMINATING PAINT.—I should be glad to have the address of a maker of illuminating paint.—S. C.

STEEL CASTINGS.—Would any of your readers give me any information as to the theory of moulding and casting the above? Also if there is any work published on the subject?—MOULDER.

ELECTRO-PLATING.—Could any reader kindly inform me how I best could re-electro.plate a tricycle? The cheapest and simplest style will oblige.—CLUB TANDEM.

COST-KEEPING.—Can any of your numerous readers recommend me to a good practical cost clerk, who can teach a reliable system of cost-keeping, not merely a theoretical system, but a practical one, involving the least labour to arrive at results?—R. H.

TWIST DRILLS.—Can any reader give me any information regarding these? Are they milled? If so, how? Is cutter arranged to get the under-cut? How are they ground for clearance? Could they be cut in a lathe?—A. R.

DESIGNING ENGINE CYLINDER.—I intend making a steam engine, 3in. bore, 6in. stroke. Would some one kindly show me how to find the size of posts, and thickness of material, cylinder and steam chest (ordinary cast iron); also length of connecting rod?—BOLT.

PROPELLER.—What will be the angle at the root and point of a propeller blade, 4ft. 2in. diam., 7ft. 8in. pitch, 11½ diam. of boss, by formula or diagram? Also, is it at the widest part of the blade that takes the angle to find the pitch when propeller is in dry dock?—ALPHA.

STEEL PLATES.—Will some reader kindly give me a list of lengths and widths of iron and steel plates kept in stock by most merchants. What I want is to be able to design tanks, boilers, &c., without having to get them cut, as this increases the labour, and does not add anything to the strength.—H. L. C.

ELECTRIC BATTERIES.—(1) Would any one alone of the following cells—Danniell's, Leclanché, or bichromate—be strong enough to decompose acidulated water? If not, how many would be needed in series? (2) How many of either kind—Danniell's, Leclanché, or bichromate—would be needed to light and maintain a small glow lamp, say of 6 c.p., and how should they be arranged? and (3) would a Danniell's cell work connected to a bichromate or a Leclanché celll, or *vice versa*?—VOLT.

MARINE ENGINES.—Will some engineer kindly give me his opinion on the following matter? Assuming a compound marine engine, with cylinders of 46in. and 88in. by 4ft. 9in. stroke, 64 revolutions, boiler pressure 108lb., cut-off in h.-p. cylinder at ⅓ stroke, developing 3,300 i.h.p. on a coal consumption of 1·78lb. and 15lb. per square foot of grate, what would probably be the coal consumed and boiler pressure maintained to give similar power if the large cylinder only were worked.—ANTIPODES.

REGULATING ENGINES.—Will some of your readers kindly give me their experience as to the best arrangement for regulating an engine with constantly varying and extreme loads; *i.e.*, whether to apply sensitive governor to throttle or to variable cut-off gear. The particular engine I have in view has slide valve with cut-off plates on back, and boiler pressure of 70lb.—X. Y. Z.

TO CORRESPONDENTS.

Saturn.—Your best course is to apply to one of the electrical journals, say the *Electrical Review*, 22, Paternoster Row, London.

H.—We have no information on the matter.

J. H.—The part played by the second wheel is simply that of a carrier.

Novice.—Your solutions are correct.

Nimrod.—(1) The letter appeared in the issue of the *Oldham Chronicle* for Saturday, March 17th. The price of single copy is 1½d. (2) Subject matter of patents has had to give place to other matter for want of room. (3) Write to the Secretary of the Hull and District Institution of Naval Architects.

J. D. P.—Communication received. The engine was entered at the Royal Agricultural Show as being new. Possibly the original idea you speak of was not perfected.

MISCELLANEA.

Nut-lock.—A very effective American nut-lock consists simply of a washer made of ¼in. square bar steel twisted and bent to a warped surface. It is in use on many railroads, and its cheapness is greatly in its favour.

A Powerful Moulding Machine.—An unusually powerful wood-working machine has been lately constructed by the Egan Co., Cincinnati. It is stated that it will take a single plank of solid wood, 14in. by 4in., of ash, oak, or maple, or any hard wood, reducing it in one cut to a single moulding, cutting a depth of 3in. in the main head, and 2½in. with the lower and each side head.

Ebony can be imitated on wood by first painting with a one per cent solution of sulphate of copper. When perfectly dry, the wood is painted over with a liquid consisting of equal weights of aniline, hydrochloride, and spirits of wine. The blue vitriol acts on the aniline, and forms nigrosin, a black which cannot be affected by acids or alkalies. A lustre can be added by coating with simple copal varnish.

The Ribble.—The new cut for the diversion of the Ribble at Preston in connection with the dock and river improvement was opened on Saturday by Alderman Bibby, the chairman of the Ribble Committee of the Corporation. Powers are being sought to borrow another large sum to complete the scheme, and it is estimated that the works will cost £1,000,000, should sanction be given to the expenditure of the additional amount.

Locomotive Drivers.—One of the chief virtues of the locomotive driver and his companion, the fireman, is one which we are not accustomed to associate with their profession; and that is cleanliness. A clean engineer is almost certain to be an excellent one in every particular. The men upon a locomotive cannot, it is true, avoid getting black soot upon their faces. The point is that both the men and their engines should be clean in all the essential particulars, so that all the faculties of the men and all the devices of the engine shall work with ease and certainty.

A Hint to Teachers in Technical Schools.—Prof. Thurston, of Sibley College, Cornell University, has issued a circular to a number of prominent manufacturing firms, calling attention to the fact that a considerable body of highly instructed young men is annually turned out from that institution, and suggests that they might with great advantage find places in various technical establishments. He also wishes to know whether it would not be possible to adopt a plan, long in operation in foreign countries, by which large establishments take each year a specified number of young men and give them opportunities to learn the business, and asks that the recipients of the circular give him information of the number of these young men whom they will take, with compensation, and other particulars.

Torpedo Boats.—An exhibition was given on Monday, on the Thames, of the second-class torpedo boats built by Messrs. Yarrow and Co., of Poplar. These new boats, of which a considerable number will be required for the navy, are the outcome partly of certain instructions from the Admiralty, and partly of the constructive skill of the builders. The old second-class boats, meant to be hoisted and lowered from the side of a ship, were excessively narrow and crank, and useless except for their own special purposes, and for these only in fair weather. Now, the disadvantages of such boats were obvious. Apart from their crankness, the men were never familiar with them, their machinery suffered from disuse, and it was necessary for a ship to carry a separate steam pinnace for ordinary use. The new type of boat has a beam of 8ft. 6in., and possesses considerable stability. She can carry two Nordenfelts and a three-pounder quick-firing gun, and may be used generally as a steam pinnace. These immense advantages have been attained without any loss of speed. In fact, the new boat can steam seventeen knots an hour, whereas sixteen knots was the maximum of the older boats. Another important advantage is that by the fineness of her lines forward the new boat raises no great wave as she cuts through the water at a high speed, and experience has proved that this wave is very easily detected by those on the outlook. The torpedoes are fired from tubes in the stern of the boat by an ingenious arrangement, and she will thus be enabled to discharge her torpedo and sheer off while still going at full speed. The boat was inspected by the naval *attachés* of several foreign Governments.

SELECTED PATENTS.

August 18, 1887.

18034	Tapping Stay Bolt Holes, J. T. Connelly, London.—[Complete Specification.]

March 14th.

3920	Coating Iron and Steel with Tin, J. Thornton, Redditch.
3929	Dynamo-Electric Machines, T. Parker, E. Scott, G. Rees, and J. H. Woodward, Manchester.
3937	Shaping Metals, E. Heap, Manchester.
3939	Steam Traps, W. Matthews and J. Yates, Manchester.
3954	Automatic Measuring and Delivering Tap, J. D. Solomon and J. E. Thorpe, London.
3956	Automatic Lubricators, J. Dean, London.
3957	Feeding, Heating, and Circulating Water, J. Gilmour, London.
3959	Transmitting Power a Distance, C. E. Owens and C. Butler, London.
3961	Machinery for the Manufacture of Tubes and Wire, E. Mapplebeck, Middlesex.
3964	Gas Engines, E. H. Gazé, London.
3972	Grinding and Polishing Machines, S. Bellotti, London.—[Complete Specification.]
3984	Consuming Smoke, R. Gosling, London.

March 15th.

3998	Electrical Indicator, T. C. R. Horsfield and R. Porter, London.
3999	Punching and Shearing Machinery, D. Smith, jun., Wolverhampton.
4010	Automatic Fog Signal, J. W. Farrar, J. Wildman, and W. Burns, Lancashire.
4015	Removal of Banks in Rivers, J. M. B. Baker, Kettering.
4017	Electric Arc Lamps, G. E. Dorman, Stafford.
4021	Steam Boilers, E. Crompton and J. T. Cochran, Liverpool.
4026	Taps or Cocks, T. A. Venimore, London.
4027	Hauling Gear, E. Urry and J. W. Tasker, London.
4033	Slip Bolts or Locks, A. Dimmack, Glasgow.
4040	Lamps for Burning Petroleum, P. C. Brewster, London. (J. Ehlis, Belgium.)
4045	Lock Nuts, A. Vogt, London.
4046	Lock Nuts, A. Vogt, London.

March 16th.

4057	Compressed Air Motors, J. H. T. Turner and A. W. Brightmore, Liverpool.
4061	Stop Cocks, R. Howarth, Wolverhampton.
4065	Lock Nuts, T. W. Willis and J. Tuxford, Sheffield.
4066	Boiler Cleanser, J. W. Taylor, Stanford-le-Hope, Essex.
4068	Taps and Valves, J. Lancashire, Oldham.
4072	Miners' Lamps, J. Muller, Manchester.
4077	Manufacture of Edge Tools, S. S. Hazeland, Cornwall.
4079	Machine Belting, R. Simpson, Sheffield.
4080	Set Screw, A. Samson, Camberwell.
4085	Differential Pulley Blocks, W. Wood and T. Wrightson, Stockton-on-Tees.—[Complete Specification.]
4086	Metallic Alloys, J. C. Bull, London.
4087	Safety Lamps, W. Clifford, London.
4089	Nut Locks, J. E. Lansard, London.
4092	Printing Machinery, G. Weldon, London.
4096	Type-writing Apparatus, M. A. Wier, Middlesex.
4098	Railway Rails, R. Punshon, London.
4099	Refrigerating Machines, J. H. Newton, London.—[Complete Specification.]
4101	Safety Lamp, C. Wells and E. Charles, Middlesex.
4103	Ventilators, F. H. Street and C. Ellis, London.
4107	Weighing Machines, O. Fleischhauer, London.
4115	Stop Cocks, S. Ziani de Ferranti, London.
4117	Apparatus for Testing Pressure, E. A. Hoad, London.—[Complete Specification.]

March 17th.

4121	Furnaces, J. Proctor, Manchester.
4136	Smoke Consumer, J. Pickles and J. Mitchell, Bradford, Yorkshire.
4144	Mariners' Compasses, T. Harrison, Liverpool.
4152	Side-valves, J. Gaskell, Manchester.
4160	Valve-gear, N. A. Bonnefoud, London.
4163	Proportional Compasses, J. H. Berger, London.
4167	Connecting Pipes and Tubes, G. W. H. Brogden, London.
4168	Vehicle Couplings, C. Lock, London,
4171	Electrical Governor, W. S. Freeman, London.
4172	Printing Presses, J. F. W. Dormau, London.—[Complete Specification.]
4173	Spark Arrester, J. H. Swartzbaugh, W. Hyter, and T. L. Park, London.—[Complete Specification.]

March 19th.

4176	Flange Pipes for Steam Conduits, J. Kudlicz and G. Ahlemeyer, Paris.—[Complete Specification.]
4179	Lubricator, R. Garrett, Bath.
4183	Miners' Safety Lamp, W. Lloyd, Wigan.
4186	Thermo-motors, J. Hargreaves, Liverpool.
4187	Manufacturer of Oxide of Iron, T. Bayley, Birmingham.
4188	Arg Lamps, F. J. Beaumout and J. Kent, Surrey.
4191	Machinery for Drilling Rock, J. K. Gulland, London.
4201	Motor and Boiler, P. Sylbe, London.
4212	Thermometers, J. J. Hicks and T. P. Salt, Middlesex.
4216	Brakes, L. Abraham, London.
4221	Holders for Incandescent Lamps, T. Coad, London.

March 20th.

4237	Portable Tires, A. F. Bell, London.
4246	Smoke-Consuming Furnaces, E. Aykroyd, Bradford, Yorkshire.
4247	Furnaces, E. Aykroyd, Bradford, Yorkshire.
4254	Tempering Wire, E. W. Gillon, F. P. Smith, and G. W. Wales, London.
4263	Chill Rolls, B. D. Martin, Birmingham.
4265	Compressing Air, J. Parker, London.
4266	Lubricators, J. W. Gaukroger and W. A. Sykes, London.
4281	Lining Furnaces in the Manufacture of Iron, J. Beasley and A. J. Wood, Middlesex.
4300	Brakes, T. de Coar and W. Keast, London.

March 21st,

4319	Speed Regulators, J. Lumb, Manchester.
4330	Dynamo-meters, P. Fuess, London.
4336	Fluid Meters, J. Allmann, Manchester. (E. Abegg, Switzerland.)
4342	Feed-water Purifier, R. W. B. Sanderson, Manchester. (J. O'Brien and S. J. Weaver, United States.)

NOTICE TO NEWSAGENTS AND SUBSCRIBERS.

Numerous complaints having been made to us by Subscribers of the difficulty they experience in obtaining copies of the *Practical Engineer* in certain districts, we have to state that the Journal can be obtained by any Newsagent through the ordinary trade channels, and no difficulty should therefore exist in obtaining copies by order of any Newsagent.

For the information of the trade, we may state that copies can be obtained from either of our Offices in London or Manchester, or from any of the following wholesale houses.

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W. H. SMITH & SON, Blackfriars Street, Manchester.
JOHN HEYWOOD, Deansgate, Manchester.
ABEL HEYWOOD & SON, Oldham Street, Manchester.
J. MENZIES & CO., Hanover Street, Edinburgh.
J. MENZIES & CO., Drury Street, Glasgow.
W. LOVE, 236, Argyle Street, Glasgow.
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C. C. ROSS, Side, Newcastle-on-Tyne.
STONEY LEES, 27, Hartshead, Sheffield.
CHAS. H. JOHNSON, Corn Exchange, Leeds.
C. CONLAN, 146, Richmond Road, Liverpool.
THOS. HAYNES, 6, James Street, Dock, Cardiff.
R. SIMPSON, 38, Wilson Street, Middlesbro'-on-Tees.
GEORGE BROMBY, 26, Charles Street, Hull.
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&c., &c., &c.

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EDITORIAL NOTICES.

All communications for the Editor of this Journal should be addressed to 6, Victoria Station Approach, Manchester.

Communications intended for insertion in the current week's issue should reach us not later than Tuesday Evening.

We cannot undertake to return rejected manuscripts or drawings unless accompanied by a stamped and directed envelope.

Contributors are requested to write on one side only of the paper. Sketches should be sent on separate sheets.

TO ADVERTISERS.

Advertisements intended for insertion in the current issue should reach us on Wednesday morning at the latest.

Important Notice to Newsagents and Subscribers.

Our Publishing Offices in London are now at 11, PATERNOSTER BUILDINGS, E.C., where the Trade will in future be supplied.

Simultaneously with the above change, our PUBLISHING OFFICES in MANCHESTER have been REMOVED from Grosvenor Chambers, Deansgate, to more commodious and convenient premises at 6, VICTORIA STATION APPROACH, where all communications intended for the Manager or Editor should, in future, be addressed.

THE
PRACTICAL ENGINEER.
APRIL 6TH, 1888.

BAD VACUUM: ITS CAUSES AND CURE.—II.

WHERE the pressure in the condenser is reduced to a minimum, or in other words, which will perhaps be better understood by many of our practical readers, where the "vacuum" is good in the condenser and defective in the cylinder, as mentioned in our previous article (see page 74), another cause of this, in addition to the one already noted, may be badly-designed steam ports and passages. When the steam or exhaust ports are too small, and the steam after doing its work and being released has to pass through a restricted or tortuous course on its passage to the condenser, which may perhaps be a long way from the cylinder, there will generally be found a considerable difference between the vacuum obtained in the condenser and the effective vacuum on the piston, and the remedy for this can of course, as a rule, only be found in an entire re-arrangement of the different parts. By bringing the condenser nearer to the cylinder, so that the exhaust steam may have less distance to travel before being condensed, some improvement may often be effected; but it is not a good plan to introduce the injection or condensing water in the exhaust pipe itself not far from where the exhaust steam leaves the cylinder, as is not unfrequently done, with the mistaken idea of effecting the condensation of the steam as soon as possible after having done its work in the cylinder. When the injection water and partially-condensed exhaust have to travel some distance together through a considerable length of exhaust pipe, the escape and condensation of the steam appear to be impeded, and it is always best to have the communication between the cylinder and condenser as short and direct as possible, the exhaust passage gradually enlarging wherever practicable like a trumpet mouth from the cylinder to the condenser, and in the latter vessel, the aim should be to give a large area of cooling surface over which the attenuated steam may rapidly spread and condense, rather than to give large condenser capacity without regard to the surface area. Where high piston speeds are run, and the ports and passages are not made correspondingly large, the only remedy for defective "vacuum" due to this cause alone is either to run at a slower speed or to replace the cylinder, valves, &c., with others having larger thoroughfares. This frequent cause of a poor cylinder vacuum may be detected by taking a diagram with the engine running at a slower speed than ordinarily, or with a less load, and in figs. 4 and 5 we give an example, showing the difference in the vacuum obtained in the same cylinder with a heavy load on the engine, and running at a speed of 64 revolutions per minute (the cut-off valve being set full open so as to carry the steam on the full length of the stroke), and with a lighter load and earlier cut-off, the revolutions of the engine being reduced to 44 per minute. Both these diagrams are from the front end of the cylinder. The steam ports of this engine, which had a piston area of 310 square inches, and a stroke of 5ft., were only 7½in. long by 1¾in. wide, equal to little

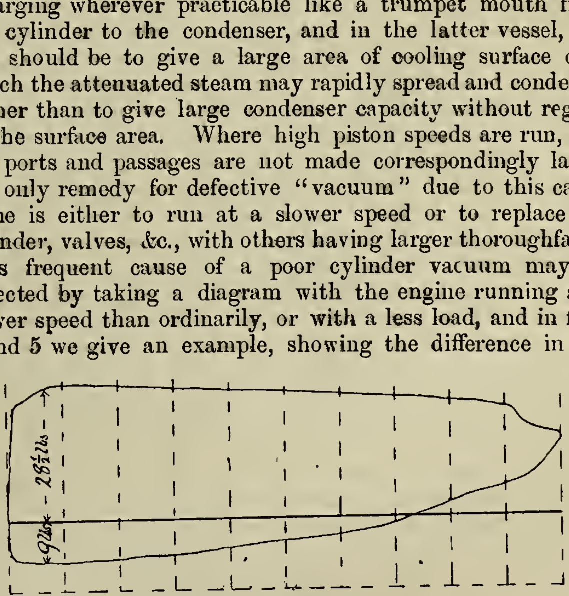


FIG. 4.

more than 13 square inches area, or about one twenty-fourth the area of the piston. When the diagram shown in fig. 4 was taken the piston speed was 640ft. per minute, and for this speed of piston and area of cylinder there should have been an area of steam port considerably more than double the actual area of the ports, in order that the mean velocity of the steam should not exceed 100ft. per second. The result is seen in the difficulty with which the steam escapes, as shown by the diagram (fig. 4), the piston having travelled over nearly one-third of the return stroke before the resistance to its motion is less than atmospheric pressure, the exhaust or back-pressure line crossing the atmospheric line at about three-tenths from the end of the stroke. Even for the reduced speed of 440ft. per minute the ports should have had an area about one-and-three-quarter times greater than the actual area, but the load being lighter, and the steam able to escape more freely, there is an improvement in the maximum vacuum at the termination of the return stroke of not less than 4½lb., whilst the back pressure opposed to the piston's return motion is not less than 7lb. below atmospheric pressure, even at the commencement of the return stroke.

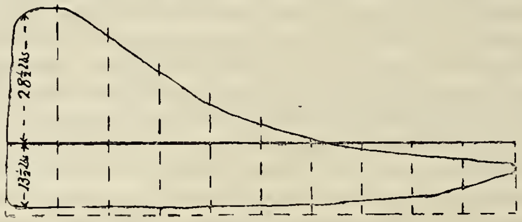


Fig. 5.

Where the vacuum in the condenser is unsatisfactory through the admission of air at some point, as, for instance, when one of the injection pipe joints is defective or a pipe is fractured at some part, or has a hole in it through which air can enter, this will often be indicated in the discharge of the ejection water at the delivery valve or valves. When there is no air present the water will be discharged in a solid body (if such an expression may be applied to water), but where air is mixed with it, the water appears frothy and "churned up," and is discharged with a great amount of splashing, &c. A few instances from the writer's own experience may be mentioned where the vacuum was impaired by the admission of air. In one case a considerable amount of money had been ineffectively spent in putting in new side pipes, new slide valves, renewing the piston, and boring out the cylinder, &c., before it was decided to seek for the cause by baring the injection pipes. These pipes at one point were considerably below the level of the cooling reservoir, and it was here that one of the pipes was found broken through, and the two portions of pipe completely severed. The water flowing from the reservoir had loosened the earth round about the pipe, and a large cavity had been formed in the ground, which filled with water whenever the engine was standing. On starting the engine this was soon pumped empty, and the result was, when the engine was indicated, that a good steady vacuum was at first shown on the indicator diagram, which gradually got worse and worse until sufficient water could not be obtained to condense the steam, and the engine came to a standstill. When a new length of pipe had been inserted, no further trouble was experienced. In another similar case, on the cold-water pipes being bared, one was found fractured completely round, close to one of the flanges. If after baring the injection pipes they can be just covered or surrounded with water, as can be mostly done when the pipes lie in a trench which has been dug in baring them, the defective part can generally be easily detected by the peculiar noise made by the air and water being forced by the atmospheric pressure into the hole, or defective joint, or fractured portion. Another mode of detection is to seal up the inlet end of the pipes and turn steam into them from the engine, when the steam will escape and betray the whereabouts of any bad joint, fracture, or hole in the pipes, &c.

STEEL ARMOUR TESTS.

The first experiment which is to decide the relative merits of solid steel v. steel-faced armour took place on Saturday week by the English Admiralty, at Portsmouth. The expense of the trials will be borne by the Government, and the competition is confined to English makers, many of whom have sent specimens for the ordeal. Not only is it expected that the relative merits of each kind of armour plate will be revealed by these experiments, but also that of the various patents and manufactures will be tested. A new 6in. breechloader, firing chilled and Holtzer forged steel projectiles, was used to bombard the plates; the charge was 48lb. of powder; shot weighed 100lb.; velocity, 2,000ft., and energy 2,800 foot tons. The range is only 10 yards, and the plates are of a uniform thickness of 10½in., and measure 8ft. long by 6ft. wide. Messrs. Charles Cammell and Co.'s compound plate was first tested, with the following result: Two rounds of chilled Palliser projectiles made no impression. Two of Holtzer's forged steel shots imbedded themselves to a depth of about 5in., and caused much deformation. A solid forged steel shot, specially hardened, went through the plate, while another steel projectile penetrated to a depth of 5in., and then fell away. There was no lamination of the plate, and the success achieved by compound armour was considered very gratifying by those present. This concluded the first test.

LITERATURE.

Mechanics of the Girder. By John Davenport Crehore, C.E. New York: John Wiley and Sons.

Bridge engineers in America work out their calculations to a degree of refinement not conceived of by many engineers in this country, and as a result we have to admit that they are, as a whole, the best bridge builders in the world. Indeed, the work is almost confined to specialists who have studied the loading to which a bridge may be subjected in work and the resulting strains in the most minute manner, and who are qualified therefore to design the structure so as to withstand the loads in the best possible manner without loss or waste of material; while in this country there are no specialists of the kind, but each railway company employs its own engineers to design its bridges very much on the principle of the rule of thumb. In England, however, the bridge engineer has not the same chance as in a country like America, where long spans are frequently wanted, and this no doubt is quite sufficient to account for the apparent neglect of the subject. The Forth Bridge, when completed, will certainly be a wonderful monument to the genius and skill of the engineers who have designed and carried out its construction, and even America has as yet nothing to compare to it; but even here we are told that a vast quantity of superfluous material has been put into the structure, which, by proper proportioning, might have been saved. Mr. Crehore's book is highly mathematical from beginning to end, and only suitable for experts, though for these we have no doubt that it will become a standard publication. In this book the necessary and sufficient weight of the structure is calculated instead of being assumed, as is usually the case, and the number of panels and height of girder that render the bridge weight least are determined for a given span, line load, and wind pressure. The *a priori* method is fully explained in the text, and examples of two classes of girders are fully worked out. There are ten other classes of girders that remained to be dealt with when the author died, and these have been left over to be inserted at some future time by another engineer, Professor J. N. Stockwell, who has promised to undertake the task.

SOME PRACTICAL NOTES ON MARINE ENGINEERING.—XII.

(*Continued from page* 100.)

DESIGN AND CONSTRUCTION OF BOILERS.

In boiler shells the Board of Trade allow 29 tons per square inch for steel, and have a minimum factor of safety of 5. The factor is increased under certain circumstances according to the method of construction adopted—thus, add ·1 if the circumferential seams are lap and double riveted; ·2, if lap and single riveted; ·3, if the holes in longitudinal seams are drilled out of place before bending; ·3, when the boiler is of such a length as to fire from both ends. When, however, the circumferential seams are lap and treble riveted, with a calculated strength of not less than 65 per cent of solid plate, this addition may be omitted. If the longitudinal seams are lap and double riveted, add ·2; if they are lap and treble riveted, add ·1. The other cases, 19 in all, appear to apply to boilers when they are not of the most approved construction or are faulty in design or workmanship.

Regarding the longitudinal seams, it will be found in practice that the thinner plates have the least percentage of joint, and as they increase in thickness up to say 1in., the percentage increases: Thus, for $\frac{7}{16}$ and $\frac{1}{2}$ plates 80 per cent would be large even for a double butt strap, while for a lap joint it would be entirely unsuitable at 160lb. pressure. Excepting for lightness, $\frac{1}{32}$in. in thickness is scarcely worth considering in small work, and therefore there is a larger margin to come and go on in designing the joint; but for heavy plates a similar increase in thickness means a good deal, not only in weight for handling in the shop, but for getting the work done in the machine. Therefore a difference between 80 and 86 per cent joint may easily mean $\frac{1}{16}$ difference in the shell. Thus a plate 1in. thick would give a boiler 10ft. 10in. mean diameter at 80 per cent, but would give 11ft. $7\frac{3}{4}$in. mean diameter at 86 per cent; or, taking the latter diameter for 160lb., the plate would have to be increased to $1\frac{1}{16}$ full if 80 per cent strength of joint could only be reckoned on. For the width of butt strap take the Board of Trade formula—

$$\text{thus—}\frac{4}{10} d \times \frac{6}{10} p = \text{diagonal pitch}$$

where d = diameter, and p = pitch of rivets

Allow not less than a full diameter of rivet for plate at edge.

As regards the number and diameter of rivets for the longitudinal joints, the combinations being so numerous, it would take too extensive a table to give in detail the proportions for each thickness of plate, and therefore, after fixing upon the diameter of rivet, the designer will best proceed as explained in our last article (page 99); but for the circumferential joint, where lightness is of more importance than strength, provided there is not less than 50 per cent of section retained, the diameter of rivet for each thickness of plate does not vary very much. We therefore give a short description for high pressures.

The circumferential seams are always lap jointed, and may be either single, double, or treble riveted, though the single joint should only be adopted in boilers of very small diameters and in steam receivers. Comparatively closely pitched zig-zag double row is best suited for this seam; trebled riveted seams have, however, been largely used, especially for big double-ended boilers, and particularly for the centre courses. Where the end seams are also treble riveted, the flanges have to be of great depth—as much as 11in. for $1\frac{3}{8}$ rivets; therefore they are usually double riveted. The seams should be of good breadth, otherwise they are sure to give trouble by leaking on the bottom side of shell. Generally speaking it will be found that a single rivcted landing can be made from 50 to 60 per cent of *plate* section; a double landing from 60 to 67 per cent; and a treble one from 67 to 70 per cent. The rivet area, compared with the solid plate, cannot well be made equal to the larger of these percentages for each respective joint; thus, for the 50 per cent the rivet will be about 1·5 times that of plate, while with one rivet for 60 per cent its diameter would be 1·8 times the thickness, which for heavy plates would be impracticable. A double joint with 60 per cent of rivet area would have a rivet about 1·15 thickness of plate, and the pitch 2·62 diameter of rivet, while for 67 per cent of rivet area the diameter of rivet would have to be 1·5 times the thickness of plate—again too much for practical working. For treble riveted 67 per cent the diameter of rivet would be about 1·02 times the thickness, and the pitch 3 times the diameter of rivets; for 70 per cent the diameter equals 1·16 times the plate and the pitch 3·3 times the diameter.

It must be borne in mind that for steel rivets in steel plates the shearing strength of a rivet is about 85 per cent of the tensile strength of the material, or, as given in the Board of Trade instructions, if steel rivets are used, their section should be at least $\frac{28}{23}$ of the net section of the plate, if the tensile stress of the rivets is not less than 28 tons, and not more than 32 tons per square inch.

These may be summed up in the following table:—

CIRCUMFERENTIAL SEAMS.

Single Riveted.				Double Riveted.				Treble Riveted.			
Thickness of Plate.	Dia. of Rivet.	Pitch from.	Pitch to.	Thickness of Plate.	Dia. of Rivet.	Pitch from.	Pitch to.	Thickness of Plate.	Dia. of Rivet.	Pitch from	Pitch to
$\frac{3}{8}$	$\frac{3}{4}$	$1\frac{1}{2}$	...	...	...	...	...	1	$1\frac{1}{32}$	$3\frac{3}{32}$	$3\frac{3}{8}$
$\frac{7}{16}$	$\frac{3}{4}$	$1\frac{1}{2}$	...	$\frac{7}{16}$	$\frac{3}{4}$	$1\frac{15}{16}$	$2\frac{1}{4}$	$1\frac{1}{16}$	$1\frac{3}{32}$	$3\frac{9}{32}$	$3\frac{9}{16}$
$\frac{1}{2}$	$\frac{3}{4}$ to $\frac{7}{8}$	$1\frac{1}{2}$	2	$\frac{1}{2}$	$\frac{3}{4}$	$1\frac{15}{16}$	$2\frac{1}{4}$	$1\frac{1}{8}$	$1\frac{5}{32}$	$3\frac{7}{16}$	$3\frac{11}{16}$
$\frac{9}{16}$	$\frac{7}{8}$ to $\frac{15}{16}$	$1\frac{3}{4}$	$2\frac{3}{16}$	$\frac{9}{16}$	$\frac{3}{4}$	2	$2\frac{5}{16}$	$1\frac{5}{32}$	$1\frac{3}{16}$	$3\frac{9}{16}$	$3\frac{7}{8}$
$\frac{5}{8}$	$\frac{15}{16}$ to $1\frac{1}{16}$	$1\frac{7}{8}$	$2\frac{1}{2}$	$\frac{5}{8}$	$\frac{13}{16}$	$2\frac{1}{8}$	$2\frac{7}{16}$	$1\frac{3}{16}$	$1\frac{7}{32}$	$3\frac{21}{32}$	4
$\frac{11}{16}$	$1\frac{1}{16}$ to $1\frac{1}{8}$	$2\frac{1}{8}$	$2\frac{3}{4}$	$\frac{11}{16}$	$\frac{13}{16}$	$2\frac{3}{16}$	$2\frac{1}{2}$	$1\frac{7}{32}$	$1\frac{1}{4}$	$3\frac{3}{4}$	$4\frac{1}{8}$
$\frac{3}{4}$	$1\frac{1}{8}$ to $1\frac{1}{4}$	$2\frac{1}{4}$	$2\frac{15}{16}$	$\frac{3}{4}$	$\frac{7}{8}$	$2\frac{1}{4}$	$2\frac{5}{8}$	$1\frac{1}{4}$	$1\frac{9}{32}$	$3\frac{7}{8}$	$4\frac{1}{4}$
$\frac{13}{16}$	$1\frac{1}{4}$ to $1\frac{5}{16}$	2^{1}	$3\frac{1}{4}$	$\frac{13}{16}$	$\frac{15}{16}$	$2\frac{1}{2}$	$2\frac{13}{16}$	$1\frac{9}{32}$	$1\frac{5}{16}$	$3\frac{15}{16}$	$4\frac{5}{16}$
$\frac{7}{8}$	$1\frac{5}{16}$ to $1\frac{7}{16}$	$2\frac{5}{8}$	$3\frac{7}{16}$	$\frac{7}{8}$	1	$2\frac{5}{8}$	3	$1\frac{5}{16}$	$1\frac{11}{32}$	$4\frac{1}{32}$	$4\frac{7}{16}$
...	...	...	...	$\frac{15}{16}$	$1\frac{1}{16}$	$2\frac{13}{16}$	$3\frac{3}{16}$	$1\frac{11}{32}$	$1\frac{3}{8}$	$4\frac{1}{8}$	$4\frac{1}{2}$
...	...	...	...	1	$1\frac{5}{32}$	3	$3\frac{15}{32}$	$1\frac{3}{8}$	$1\frac{13}{32}$	$4\frac{7}{32}$	$4\frac{5}{8}$
...	...	...	...	$1\frac{1}{16}$	$1\frac{1}{4}$	$3\frac{3}{16}$	$3\frac{3}{4}$	...	...	...	...
..	...	...	..	$1\frac{1}{8}$	$1\frac{5}{16}$	$3\frac{3}{8}$	$3\frac{15}{16}$	...	...	...	..
...	...	...	...	$1\frac{3}{16}$	$1\frac{3}{8}$	$3\frac{1}{2}$	$4\frac{1}{8}$	...	...	...	...
...	...	...	...	$1\frac{1}{4}$	$1\frac{7}{16}$	$3\frac{3}{4}$	$4\frac{5}{16}$	...	...	...	...

The breadth of the joint may be taken as follows:—

Single riveted—Three times the diameter of rivet.

Double „ —According to the Board of Trade formula the diagonal pitch = $\frac{4}{10}$ dia. + $\frac{6}{10}$ pitch; the total width of joint will, therefore, in this proportion, be from 4·4 to 4·6 times the diameter of rivet.

Treble „ —From 5·8 to ·6, times the diameter.

During the recent snow-storm, travel on the elevated railroads in New York city was completely stopped, and on the morning of the 12th ult. a line of trains over a mile long stood for several hours on the Sixth Avenue line. The passengers had no safe means of walking along the track to reach a station, and were forced to stay for several hours in the cars until rescued by ladders. The inconvenience to passengers caused by a block of any kind might be considerably mitigated by means of a railed footwalk provided along the whole length of the line, and when the enormous number of passengers incommoded is taken into account, this provision is not an unreasonable demand.

At the close of a paper read last week before the Society of Arts, by Mr. J. Stephen Jeans, on "The Panama Canal and its Rivals," the author said if a canal was to be carried across the American Isthmus, the work should be undertaken not by one nation, or State, or company, but by a convention of great Powers, responsible for the expenditure which it would involve, for the due and efficient completion of the undertaking, for its neutralisation, regulation, and maintenance. The three countries mainly interested were England, France, and the United States.

CORRUGATED FURNACES.

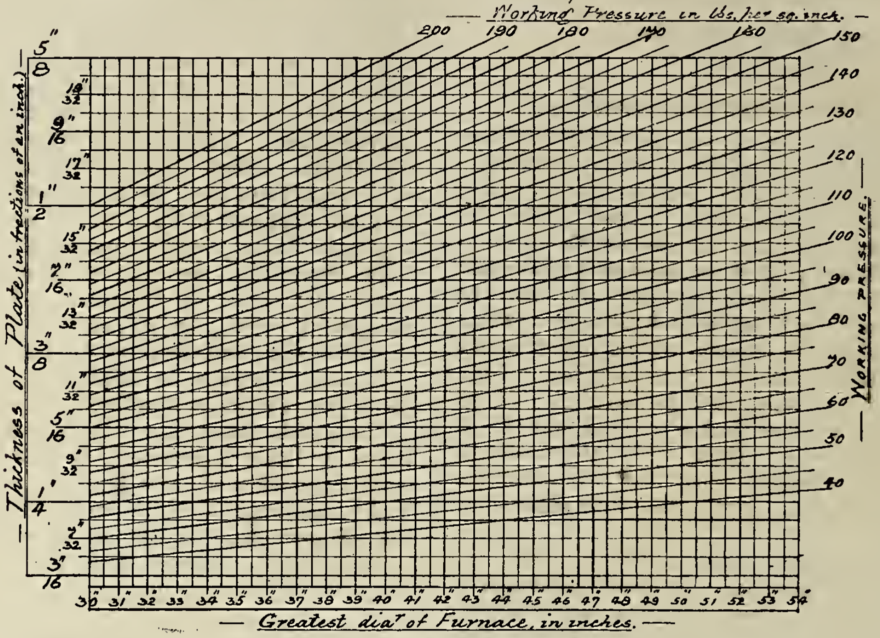


FIG. 1.

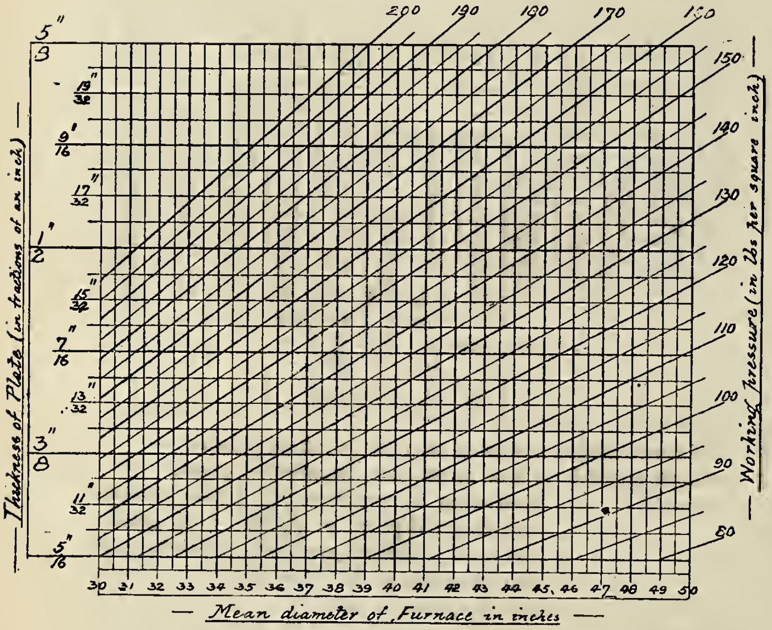


FIG. 2.

IN view of the increased number of ships having boilers fitted with corrugated furnaces, and as these furnaces have obtained a permanent footing, mainly due to, and in consequence of, the increased pressure required for the triple and quadruple expansion engine, a few remarks upon the same, coupled with a study of the accompanying diagrams, may be of interest to many readers.

From experiments carried out under the supervision of representatives from Lloyd's, the Admiralty, and the Board of Trade, a satisfactory formula was obtained by which the strength of the furnaces in question might be calculated.

A furnace made of steel ·53 thick, about 6ft. 9in. long and 3ft. $1\frac{7}{8}$in. outside diameter, having corrugations 6in. pitch and $1\frac{1}{2}$in. deep, was tested to destruction, the furnace slowly collapsing when the pressure reached 900lb. per square inch. Now, if we multiply the outside diameter in inches by the collapsing pressure per square inch, and divide by twice the thickness of the material, we shall then obtain a number which, for the purpose of comparison, we may call the ultimate crushing stress on the material, that is—

$$S = \frac{D \times P}{2\,t}$$

where S = ultimate stress, D = outside diameter of furnace in inches, P = collapsing pressure in lbs. per square inch, t = thickness of material *in inches*, so that in the above instance—

$$S = \frac{37{\cdot}875 \times 900}{2 \times {\cdot}53} = 32158\text{lb. per square inch.}$$

The collapsing pressure P could be expressed in terms of the other factors, thus—

$$P = \frac{2 \times S \times t}{D} = \frac{64316 \times t}{D} \quad (1)$$

Now, Lloyd's Committee have issued the following formula for the working pressure of corrugated furnaces :—

$$\text{Working pressure, } p = \frac{1000 \times (T - 2)}{D} \quad (2) \text{ where}$$

T = thickness in sixteenths of an inch, and
D = outside diameter, as before.

The factor (T – 2) is somewhat novel, the intention being that it will allow for a corrosion of two-sixteenths or one-eighth of an inch in each thickness of plate before the furnaces are reduced in strength to a common based factor of safety.

Now, factor of safety $= \frac{\text{collapsing pressure}}{\text{working pressure}} = \frac{P}{p}$ and as in formula (2) $T = 16t$ in formula (1), we may write $P = \frac{64316 \times T}{16 \times D} = \frac{4000 \times T}{D}$ (nearly), so that factor of safety $F \doteq \frac{4000 \times T}{D} \div \frac{1000\,(T - 2)}{D} = 4 \cdot \frac{T}{(T - 2)}$ (nearly), so that for

$\frac{5}{8}$in. plate $F = 4 \times \frac{10}{8} = 5{\cdot}$ approximately.
$\frac{9}{16}$in. „ $F = 4 \times \frac{9}{7} = 5{\cdot}14$ „
$\frac{1}{2}$in. „ $F = 4 \times \frac{8}{6} = 5{\cdot}33$ „
$\frac{7}{16}$in. „ $F = 4 \times \frac{7}{5} = 5{\cdot}6$ „
$\frac{3}{8}$in. „ $F = 4 \times \frac{6}{4} = 6$ „
$\frac{5}{16}$in. „ $F = 4 \times \frac{5}{3} = 6{\cdot}6$ „

and when each plate is worn or corroded away one-eighth of an inch, we shall still have a (constant) factor of safety of 4.

The diagram (fig. 1) gives, in a graphical manner, the working pressure which will be allowed by Lloyd's for corrugated furnaces having corrugations $1\frac{1}{2}$in. deep.

The Board of Trade have adopted the following formula for the working pressure of corrugated furnaces above $\frac{5}{16}$in. thick.

$$p = \frac{12500 \times t}{d} \quad (3)$$

where t = thickness in inches, d = mean diameter of furnace in inches, p = working pressure.

By substituting in formula (1) the mean diameter (3ft. $1\frac{7}{8}$in. less 2in.) for the external diameter (D = 3ft. $1\frac{7}{8}$in.), we obtain collapsing pressure :

$$P = \frac{60920 \times t}{d} \text{ (nearly),}$$

so that the factor of safety is

$$\frac{P}{p} = \frac{60920}{12500} = 4·87 \text{ (about)},$$

and this is constant for all thicknesses in new furnaces.

When each is reduced by corrosion or wear $\frac{1}{8}$ of an inch, the factors of safety will be approximately—

For $\frac{5}{8}$in. plate, $4·87 \times \frac{·5}{·625} = 3·9$
$\frac{9}{16}$in. „ …………… = 3·79
$\frac{1}{2}$in. „ …………… = 3·65
$\frac{7}{16}$in. „ …………… = 3·48
$\frac{3}{8}$in. „ …………… = 3·25
$\frac{5}{16}$in. „ …………… = 2·92

This shows very clearly the increased effect of corrosion upon a thin plate over that of a thick one, and will explain the reason for the factor (T − 2) in the formula given by Lloyd's.

The diagram (fig. 2) gives the working pressure allowed by the Board of Trade for steel corrugated furnaces, provided that the plates are not less than five-sixteenths of an inch thick and the plain parts at the ends do not exceed 6in. in length.

NOTE.—*Mean* diameter of furnace to be taken in Board of Trade formula. *Outside* diameter to be taken in Lloyd's formula.

Example 1.—Required the working pressure of a corrugated furnace 43in. external diameter, $\frac{1}{2}$in. thick. By diagram (fig. 1) we obtain a working pressure of 140lb. (nearly). By Board of Trade diagram (fig. 2) we get, taking mean diameter = (43 − 2) = 41in. $\frac{1}{2}$in. thick, a working pressure of 152·5 (nearly).

Example 2.—Required the thickness for a furnace 40in. diameter, *outside*, for a working pressure of 150lb. per square inch. By diagram (fig. 1) we get a result of $\frac{1}{2}$in. for the thickness (Lloyd's). By Board of Trade diagram (fig. 2) mean dia. = 38in., so that we find that a furnace constructed of plate $\frac{15}{32}$in. thick would do, as it is good for a pressure of about 153lb. per square in.

NOTE.—The diagram (fig. 2) also applies to the United States Government rule for the corrugated furnace flues of marine boilers (as given in *The Practical Engineer* of March 16th, page 130), which rule is identical with that of the English Board of Trade.

H.M.S. BENBOW.

AN important addition was made to the effective strength of the navy on Saturday by the completion for sea of the new armour-plated barbette ship Benbow, which was built by the Thames Ironworks Company, and was delivered from the contractors in October, 1886. The Benbow has been just over five years building and fitting for sea. She is 325ft. in length between perpendiculars, and has a displacement of 10,600 tons. Her armament is of a very powerful character, the ship being mounted with two 110-ton guns, the heaviest weapons ever mounted on a British ironclad. These guns are fired with a charge of 1,000lb. of powder, the projectiles weighing 1,800lb. She also carries ten 6in. 5-ton guns, mounted on Vavasseur fittings, eight 6-pounder quick-firing guns, seven 3-pounder quick-firing guns, and two 1in. and four 0·45in. five-barrel Nordenfelt guns. She is also equipped with eighteen 14in. Whitehead torpedoes, two tubes for firing which are provided on either side. The Benbow is fitted with machinery of 11,500 horse-power, and at her measured mile trials off Sheerness she attained an average speed of 17 knots on a four hours' run. She has a coal carrying capacity of 1,200 tons, which is sufficient to enable the vessel to steam 8,500 knots at a speed of ten knots. She is fitted with the electric light, and all the latest improvements in shipbuilding science. The total cost of the Benbow amounts to nearly £812,500, and the ship will be commissioned in the summer to take part in the approaching naval evolutions. The citadel of the ship is plated with armour 18in. in thickness.

TRAIN LIGHTING BY ELECTRICITY.

AN advance in the growing practice of lighting railway trains by means of electricity is to be found in a train which is in regular service on the Midland line between Derby and Manchester. The system adopted is that of Mr. Illius A. Timmis, which has been applied to a saloon carriage, a composite first and second class carriage, and a guard's van in the train referred to, and has been in satisfactory operation for some little time past. The arrangement consists of a battery of 10 of the Union Company's storage cells placed under each of the carriages and the van, each battery weighing about four hundredweight. These batteries, which are charged by a dynamo at the station at Derby when necessary, supply a current to Swan glow lamps of five candle power each, two being placed in each compartment and four in the saloon. The lights are controlled from the guard's van, and when the guard closes the controlling circuit with a switch certain electro-magnets attached to each carriage are actuated, and the lighting circuits are all broken and the lamps extinguished. By this arrangement, if any of the carriages become detached from the controlling circuit, the magnets in those carriages cease to act. The result is that the lighting circuits are automatically closed and the lamps are lighted, and if they are already lighted they remain so. Besides the controlling circuit and the working circuit there is a third, the signalling circuit, by means of which communication is effected between the passengers and the guard. When the lamps are not lighted there is no waste going on in the batteries. The cost of efficiently lighting a train of 12 or 14 carriages is stated to be equal to the consumption of half a pound of coal per mile.

NEW ENGINEERING WORKS, near GLASGOW.

MESSRS. ARCHIBALD BAIRD AND SON are presently erecting large engineering works at Hamilton, near Glasgow, where steel manufacturing operations will be carried on on an extensive scale. The new works cover an area of close on two acres, and the principal erections are the moulding and engineering departments, each of which is about 100ft. in length and 35ft. in breadth. They are built of brick, and are lofty and well ventilated. Close adjoining are the steel smelting houses, smithy, drying stove, and smelting furnaces, besides departments for the manufacture of Archangel tarred and fireproof bratticing cloth, and oils of every description; also for pattern-making and gutta-percha work. The showrooms are situated on the ground floor, immediately above which are the counting-house and offices, the stores being at the rear of this portion of the works. Each of the three storeys in this structure is 50ft. by 35ft. in extent, and are united by a hoist. The erection of the works has been for some time in progress, and are now nearing completion; indeed, they are already partly occupied, a considerable number of crucible steel castings and engineering tools, besides a quantity of mining and railway plant, having been turned out; and when the premises are in full operation, which is expected to be shortly, they will provide employment for a large number of workmen.

Messrs. Baird are able to despatch their varied products more economically from Hamilton than from Glasgow, while the atmosphere is much healthier than that of the city, and therefore more conducive to the comfort of their workmen.

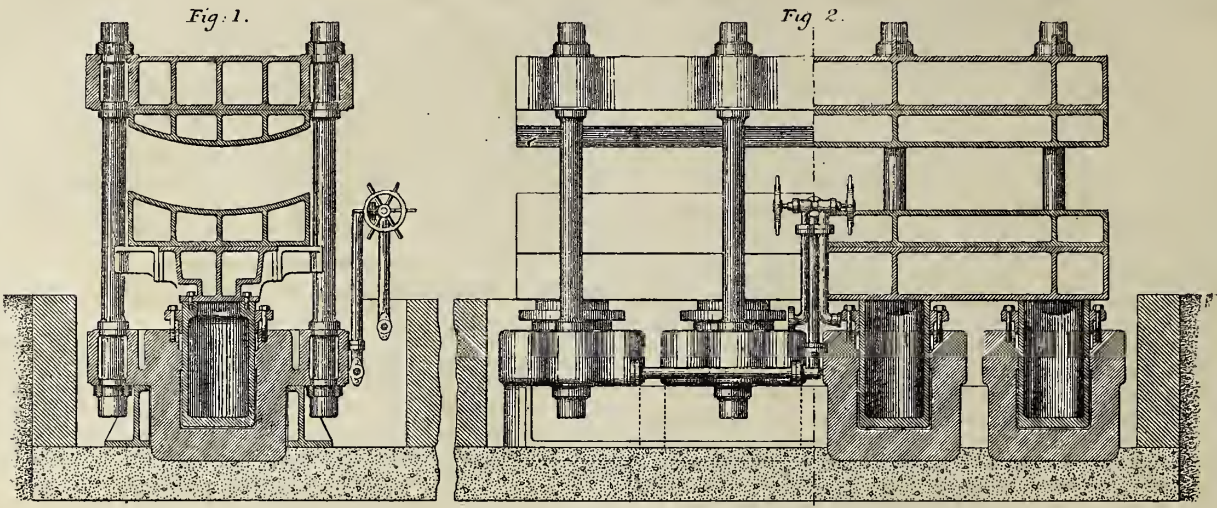
ELECTRIC LIGHTING AT THE GLASGOW EXHIBITION.

THE whole of the arc lamps—420 in number—to be used in the lighting of the interior of the Exhibition have now been placed in position. The engines and dynamos for generating the electricity have still to be fitted up. In the meantime, however, a temporary engine and one dynamo have been placed in the central section of the Machinery Court, and by this means a number of lamps can now be used, if necessary, for lighting a portion of the building at night. The installation is by the Anglo-American Brush Corporation, whose system will also be used in the grounds. The engine which has been temporarily fitted up for present use is a 10 horse-power double-cylinder high-pressure Robey. There will be on view in the grounds four different systems of gas lighting, and one example of lighting with oil, besides the electric light. The picture galleries will be lighted with electricity, 40 arc lamps, fitted on the Thomson-Houston principle, being employed for this purpose. Electricity will also be used in the large dining-rooms, the system in this case being Messrs King, Brown and Co.'s arrangement of incandescent lamps.—*Electrical Review*.

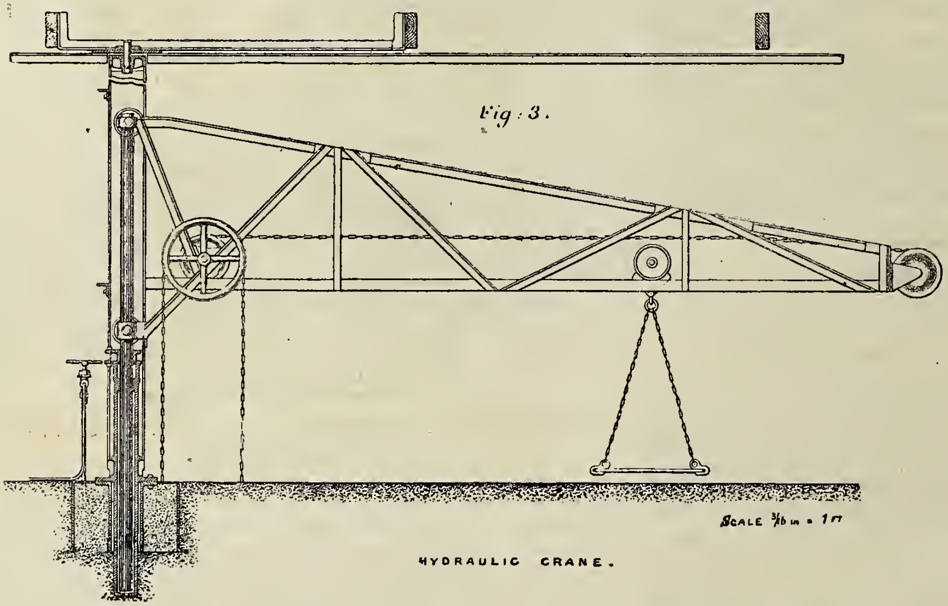
MR. THOMAS BEELEY, a well-known boiler-maker at Hyde Junction, writing to a Manchester paper, anent the Boiler Registry and Inspection Bill, draws attention to the wording of clause 7, from which he says there is no guarantee that the interests concerned shall be represented on the committee; the power lies altogether with the Board of Trade officials, who would be able to select a committee of their own liking, or to select none at all. He also draws attention to the exceptions in the bill in the cases of Lloyd's, the Railway Companies, and domestic boilers, whose interests are too well represented in Parliament for any bill to pass which would affect them. In conclusion, Mr. Beeley suggests that the whole matter might be left for management by the proposed County Councils, who will understand the requirements of the district and be representative in character.

HYDRAULIC APPLIANCES AT THE FORTH BRIDGE WORKS.[*]

BY ERNEST WILLIAM MOIR, STUD. INST. C.E.



HYDRAULIC PRESS.



HYDRAULIC CRANE.

THE Forth Bridge, in its manufacture and erection, is a work well adapted to the use of hydraulic and other special machinery, and no opportunity has been lost by Mr. W. Arrol in the introduction of labour-saving plant. There are two forms of accumulators in use at the works, through which the high-pressure water is pumped, one form having a 16in. cylinder loaded by dead weight; the other having an 8in. cylinder weighted by steam. The larger one is that used for general work, the smaller, which is portable, only for isolated jobs, or in case of a break down. All the compression members of the cantilevers are tubular; the bottom members and the columns forming the main steel pier are circular in section, the struts being flattened, so as to simplify the junctions and intersections with the other parts of the triangulation.

The heaviest plates, weighing 34cwt., are in the bottom members of the cantilevers, their dimensions being 16ft. by 4ft. 9in., and they are bent in the arc of a circle with a radius of 6ft. A hydraulic press (figs. 1 and 2) was made for the work, capable of putting a load of 800 tons between the cress blocks, with a pressure of 1,000lb. per square inch on the cylinders. It has four rams 24in. in diameter, connected at the top by a heavy cast-iron cross-head, upon which is placed the lower or concave "cress" block. Eight steel standards, 7in. in diameter, are secured to the cylinder castings, and support the upper table, as well as form guides from the lower block while it is being raised.

The rams are packed with tallowed white rope in ordinary glands, this form of packing being very much more economical in such large diameters than any form of cup leather.

The water is controlled by two ordinary brass conical screw-down valves, one for admission and one for release, the exhaust water being forced out by the weight of the rams and lower table. The plates to be set are drawn from an adjacent gas-furnace, at a red heat, upon the lower cress block of the press, by means of a chain working over multiplying pulleys on a vertical hydraulic ram, and when in position are squeezed between the dies to the desired form. The plates are removed, while warm, from the press, and laid aside to cool, during which process they generally become distorted, requiring to be adjusted when cold by placing them in the press a second time. The hydraulic cranes used throughout the sheds for handling the material, of which fig. 3 is a sectional elevation, are simple in design and efficient in working. The cast-iron cylinder is let into a cast-iron box filled with concrete, forming the foundation, and is bored to 4¼in. for the steel ram. The cantilever jib is rigidly attached to the head of the ram, and is lifted or lowered with it, transmitting the shear of its own weight and load, direct to the water in the cylinder; the bending moment being taken up by two pairs of pulleys running within the channels forming the mast. The distance between the centres of these wheels is 6ft., being made as small as is consistent with strength to allow of as great a lift of the jib as possible. The cast-iron distance-pieces between the channels of the mast form bearings, on which the crane revolves;

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[*] Paper read at a meeting of the Students of the Institute of Civil Engineers, on the 1st of April, 1887, and was awarded a Miller Prize in the Session 1886—87.

the lower one, being split, embraces the cylinder just above its foundation, while the upper one works in a bearing, attached by means of a plate and long angle-stays to the roof-trusses of the sheds. The loads are slung to a small carriage, which is travelled by means of a system of chain wheels on the horizontal bottom member of the cantilever jib. A common three-way cock controls the admission and release of the water, the weight of the jib and ram serving to force out the exhaust, when the cock is turned in such a position to allow of this being done.

(To be continued.)

MACHINES FOR PATTERN SHOPS.—III.

(*Continued from page* 140.)

BAND SAWS.

So much of the pattern-maker's work lies in sweep cutting that a good band saw soon pays for itself. The modern saws are different in many respects from their older relatives, the improvements consisting mainly in better framings and more rigid construction, in the use of lighter wheels, wheels of larger diameter, a more elastic tension, more perfect guidance, and better packing. The efficiency of the saws is greater, and the losses due to breakage much reduced. Fig. 8 illustrates a typical band saw of best construction, made by Messrs. Geo. Richards and Co., Limited, one which embodies the most approved results of the costly experience of many years, and one, moreover, which is fairly representative of the tendency of the most recent practice among the leading manufacturers of wood-working machines. Every little detail about this is designed for its special purpose, and is therefore deserving of study. We will take these *seriatim.*

Of the framing we need say no more than that it is, in common with that of the best saws now made, except the very lightest, of the boxed type, which is adopted to diminish vibration. The greatest evil which the users of band saws have had to contend with is the breaking of the blades. I have repeatedly, I am sorry to say, seen new band saws break within an hour or two of their being put on the machine, the reason being clearly traceable to the fact that this particular machine had old-fashioned heavy cast-iron wheels, that the top bearings were worn badly, and that the tension was imparted by a non-elastic weight and lever. The practice is now to make the wheels as light as possible, preferably of wrought-iron or steel, in order that their momentum shall not be excessive in amount. The reason for this is not far to seek. When the saw is being carried round by the wheels there is the same momentum throughout, and the saw is in even tension. But when a heavy cut comes on, the saw is at once put into compression stress, the resistance of the wood tending to check its motion, at the same time that the top wheel is by its momentum forcing it downwards. The condition is, therefore, analogous to that of thrusting a keyhole or compass saw forcibly downwards into wet wood—it is a pushing force which tends to bend or buckle the saw, and so cause fracture. The aim is, therefore, to diminish the momentum of the top wheel by reducing its weight; hence the reason for employing the light wrought-iron and steel structures. To make matters worse, the cast-iron wheels are not always properly turned and balanced on their spindles, and, in any case, their inertia at starting is detrimental to the saw blade which lies around them. The cast-iron wheels are still largely employed, being made as light as possible, but those of wrought-iron are preferable, and the spider-like bicycle wheels in fig. 8 are better still.

Another important matter relates to the tension of the saw. The tension is put on for two reasons, one being to compensate by an elastic automatic arrangement for the lengthening and shortening of the saw blade, due to differences in its temperature while working: the other, to relieve the saw altogether of strain when not in use. In the earlier machines this tension was provided for by supporting the bearing of the top wheel by means of a loaded lever of the first order, the weight being removed when the saw was not in use. This is now largely superseded by the use of a helical or an indiarubber spring, either of which is much more sensitive than a loaded lever. The positive strain being also imparted by a hand wheel and screw, the bearing is capable of more precise adjustment than that afforded by the uniformly loaded weight. Moreover, the sudden removal of the load due to the fracture of a saw does not produce so injurious a shock where an elastic spring is used, as occurs upon the sudden falling of the loaded lever. A carriage spring is occasionally employed instead of the helical spring, and, though not so neat, it fulfils the same purpose, that of allowing the whole combination, —pulley, bearing, and hand wheel—a slight amount of elastic movement in order to preserve the tension uniform under varying temperatures of the blade.

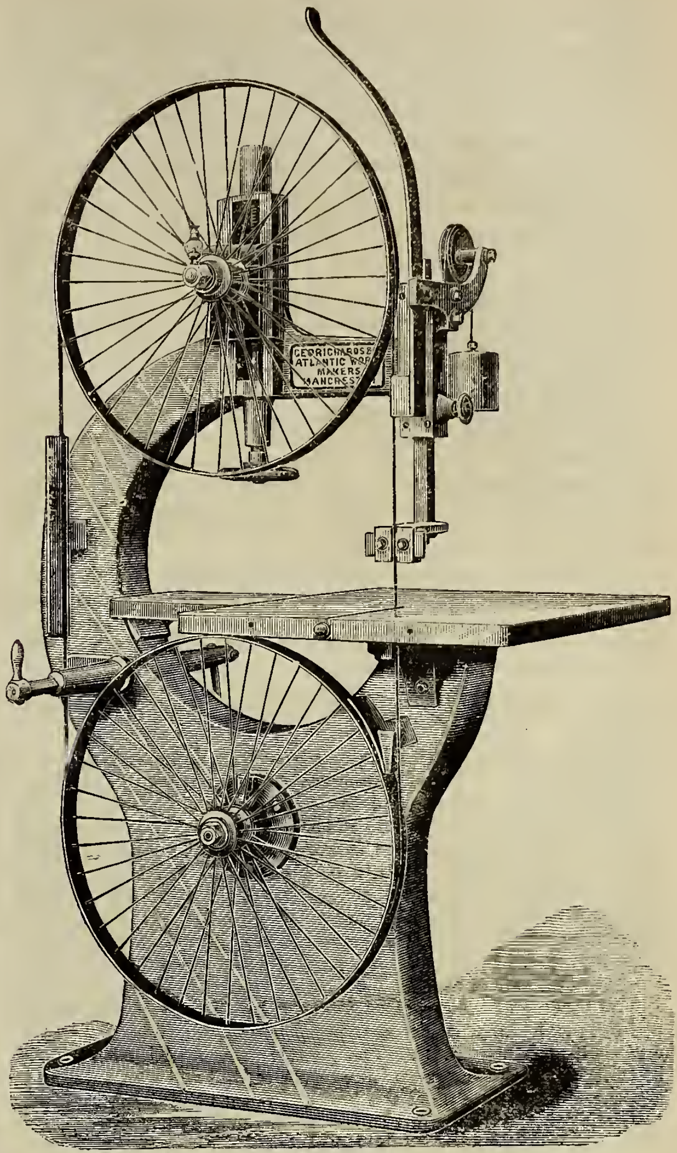


FIG. 8.

GEORGE RICHARDS AND CO., BROADHEATH.

The guidance of the saw is of no less importance than the tension. Properly, it should slide between blocks of well-oiled hard wood, placed both above and below the table, though very often the latter pair are let into the table itself. Unless these blocks are kept close fitting, it is quite impossible to prevent the saw from running to one side, becoming twisted, and breaking when working round quick curves. The end grain of the blocks should abut against the saw, and as they wear be brought up into contact again. The saw should also be supported behind, against the backward thrust. In the machine figured, a rigid steel pin takes the thrust, but most makers, I believe, prefer to use a steel roller. The upper sliding guide should always be kept close down to the surface of the wood, and then the saw is well supported, both as it enters and leaves the cut. Fig. 8 has the novel addition of a counterbalanced weight by which the mass of the upper sliding guide is counterpoised; it is therefore moved without difficulty, to be clamped in any required position.

We must not omit to mention that the diameters of the pulleys are often responsible for the breaking of saws. These are often too small, so that the saws, being perpetually bending over curves of small radius, soon fracture. These wheels should never be less than 2ft. diameter, and 2ft. 6in. as the minimum is better practice. The risk of fracture is proportionally diminished by increasing the size of the wheels, and the wider the saws, the larger in proportion should be their diameter.

Latterly the practice has been in favour of discarding the flanges at the backs of the pulleys, on the ground that they tend to cause fracture of the saws by friction. If the pulleys are properly hung, and set in line, and the guides acting efficiently, the saws cannot run off at the back, and then the flanges are superfluous. But the advantage of flanges is that when the leather or rubber with which the pulleys are covered is tapered towards the front, the saw must run towards the back, the highest part, and so being arrested by the flanges will remain on the pulleys. Evidently in the absence of flanges all depends on good fitting, but with first-class workmanship, and bearings not badly worn, they can be dispensed with.

Breakages are sometimes due to the faulty condition of the indiarubber or leather covering of the wheels. This is apt to become coated with chips and sawdust, thus producing unevenness of the surface. It ought therefore to be kept scrupulously clean by occasional scraping of the surface with a chisel while the wheels are set revolving. The bottom wheel is more subject to this evil than the upper one, the chips being mostly carried downwards through the table. In fig. 8 there is seen a small "chip guard" placed in such a position below the table as to throw any descending fragments clear of the lower wheel.

For small shops destitute of power, band saw machines are made for driving by hand. In these, smaller wheels can be used than are permissible with the other machines, because the saws are carried over three pulleys instead of two, the centres of the three being arranged in triangular relation to each other, the arc of contact being reduced thereby. The driving wheel to which the handle is attached is made larger and heavier than the other two, and acts as a flywheel.

Band saws will cut very thin or very thick stuff, provided they are kept in good order. With a saw well set and sharpened, and well guided, blocks from 6in. to 8in. thick can be cut on any ordinary smallest-sized machine made. But if the saw is in bad order, not under proper guidance, and forced, it will belly, and cut hollow, or out of square, or stick fast, and slide off the wheel, or break. Bevel sawing is done as readily as square, by canting the table.

Lastly, the efficient working of a band saw depends largely on the regularity with which the setting and sharpening are done. This is usually done in the same manner as that of ordinary saws, but there are automatic machines constructed by various manufacturers to supersede the workman's skill. Though rather costly, I believe they are truly economical in the end, because there is not merely the difference due to the time saved to be taken into account, but also the superior efficiency due to the greater regularity of machine setting and sharpening over that done by hand. Band-saw blades should be speeded to travel at the rate of about 4,000 feet per minute.

The brazing of broken saws is done by filing a scarf joint of about 1¼in. in length, and securing it fast with iron binding wire, and then with brass wire. The joint is moistened with spirits of salts, powdered borax sprinked over it, and the whole put into a clear charcoal fire until the brass runs into the joint. When cold the joint is filed down to the same gauge as the saw.

J. H.

THE THERMO-DYNAMIC ANALYSIS OF THE GAS ENGINE.*—I.

It must be our first duty to make some kind of classification, for there is a very great variety in this kind of motive power. I shall not attempt to draw fine lines of distinction, for I do not know that such could be done, even between our old friend the steam engine and the gas engine of a few years ago; but excluding the steam engine pure and simple, we may broadly divide our present subject into two distinct classes, namely, those engines using water as against those using no water at all.

These two classes we may severally divide into internal and external combustion engines, and again into regenerative and non-regenerative. And yet again into the three types referred to in Dugald Clerk's paper,† illustrated by the small diagramatic curves of expansion, and numbered 1, 2, and 3.

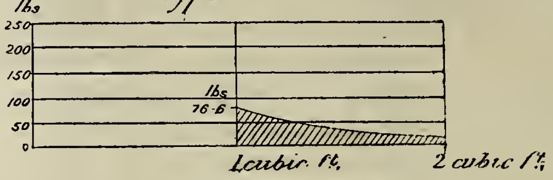
Beyond perhaps a passing remark as we go along, I purpose leaving the table as sufficient for our purpose in all those classifications except the types indicated by the small diagrams referred to. Clerk thus describes the three types :—

(1.) "An engine drawing into its cylinder gas and air at atmospheric pressure for a portion of its stroke, cutting off communication with the outer atmosphere, and immediately igniting the mixture, the piston being pushed forward by the pressure of the ignited gases during the remainder of its stroke. The in-stroke then discharges the products of combustion."

(2.) "An engine in which a mixture of gas and air is drawn into a pump, and is discharged by the return stroke into a reservoir in a state of compression. From the reservoir the mixture enters into a cylinder, being ignited as it enters, without rise in pressure, but simply increased in volume, and, following the piston as it moves forward, the return stroke discharges the products of combustion."

(3.) An engine in which a mixture of gas and air is compressed or introduced under compression into a cylinder, and then ignited, while the volume remains constant and the pressure rises. Under this pressure the piston moves forward, and the return stroke discharges the exhaust."

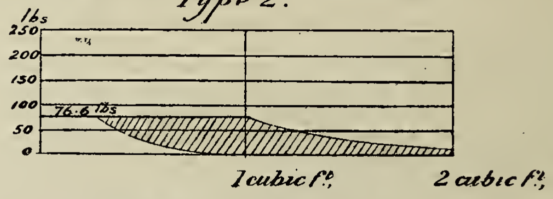
Type 1



Duty of Engine. 0·21

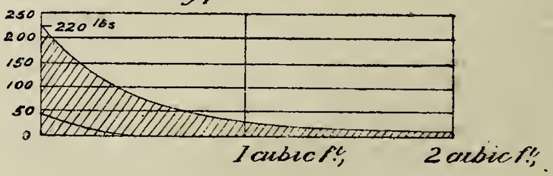
Clerk then goes on to show the relative dynamic values of these three types as 21, 36, and 45 respectively, and these figures I certainly will not dispute as far as they go. But these figures I maintain do not properly represent the relative values of the three different types, and when we have carried our analysis further I think different deductions are to be drawn than those arrived at by the author of that paper. Looking at the three types from a constructive point of view, Nos. 1 and 2 indicate a maximum pressure of only 76·6lb. per square inch, while No. 3 gives 220lb., or nearly three times that of the other two. Now, as an engine has to be proportioned to the maximum strain which may at any moment come upon it, it follows that No. 3 type must be made three times as strong as Nos. 1 and 2, and therefore more costly, though not necessarily in direct proportion. Looking at matters in this light, No. 2 would carry off the palm, for we could construct such an engine for much less money per horse power, and, again, in the matter of steadiness of running No. 3 would again be far behind the other two. And these two views are by no means unimportant items. The second series of diagrams immediately under the first three are diagrams of pressure during two revolutions or one cycle of operations of No. 3 type. And still a further item in connection with steadiness may be cited in the matter of the mode of governing, especially that system adopted in the Otto, where an entire change is cut out, and the engine has to run as many as four or six revolutions empty. No engine, then, could be arranged for greater unsteadiness than No. 3 type. Mr. Clerk improves upon this type of engine in a most admirable manner by adding a low-pressure pump, and so getting an impulse every revolution ; and as steadiness is in proportion as the square of the number of impulses, it follows that the Clerk engine is four times as steady as the Otto.

Type 2.



Duty of Engine 0·36

Type 3.



Duty of Engine 0·45.

And now let us take another view of these three distinctive types of engines, namely, that of the convenience of starting, stopping, and re-starting. Nos. 1 and 3 cannot re-start without the aid of auxiliary appliances. Even with a reservoir of air No. 1 type would require five cylinders at the very least in order to cover dead points. No. 3 would also require at least five cylinders for the same reason, except it take the form of Clerk's improvements, when three would suffice. But No. 2 is constituted with a reservoir, and, as a three-cylinder engine, could as readily re-start as the Brotherhood or Westinghouse steam engine. So, after all, in no light but the one is No. 3 type the best.

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* Paper read before the Manchester Association of Engineers by Mr. H. Guthrie.
† Proceedings of Institute of Civil Engineers, 4th April, 1882.

Nos. 1 and 3, then, are beyond all hope of ever doing certain duties we are accustomed to see the steam engine perform—that is intermittent work, such as winding and locomotion, whilst No. 2 could do the work as well as a steam engine.

To be continued.

THE LATE GEORGE H. CORLISS.

Mr. George H. Corliss, the celebrated American engineer and inventor of the Corliss engine, died on the 21st February last from the effects of paralysis, brought on by a gastric attack. Our readers will be interested in the following brief account of his career, which we extract from a sketch in the *Providence Journal*, by J. A. Coleman.

By a fortunate accident Mr. Corliss, when a young man, came to a Rhode Island steam-engine establishment to construct a sewing machine of his invention. While thus engaged he was diverted from his purpose by an exigency suddenly occurring in the establishment, and his attention was thenceforward directed to the improvement of the steam engine. The invention of the attachment of the James Watt Regulator to a liberating valve gear was the result.

This improvement produced so great an economy in the consumption of coal in manufacturing establishments that the Corliss engine in time superseded all others. It also enabled a uniform speed of the machinery in manufactories of textile fabrics to be obtained by its almost human intelligence in regulating its own power to its constantly varying work. For the first time in the history of cotton spinning could the machinery of a mill be run without jerks, and the consequent breaking of threads throughout the mill, with the attendant vexation and loss.

In 1867 the Corliss engine was exhibited in Europe for the first time, at the Paris Exposition, where it received the highest awards, and the engine was copied throughout Europe to such an extent that at the Vienna Exposition in 1873, out of about four hundred engines the majority were of the Corliss type, and Mr. Corliss again received the highest awards, although not a pound of machinery, nor even a drawing, were exhibited by him. Again at Paris, in 1878, scarcely one engine was shown out of hundreds built upon any other plan. It may be said to be the standard form of stationary engine, in pure or modified form, throughout the civilised world.

The success of the Corliss engine in America was not reached in a moment. Like all great innovations, at the commencement it was assailed by established prejudices and vested interests with vituperation and scorn. This was not strange. The strong individuality of the inventor was emphatically characteristic of his engine. Radically different in theory, operation, and appearance, elegant and refined among engines, as its inventor was among men, and, moreover, being in all things *right*, it was inevitable that it should not escape condemnation by the least enlightened of those professing to be steam engineers. The writer remembers the scornful derision with which this class greeted the first appearance of the present form of engine-bed, which is copied to-day over the entire civilised world. The bitter days of the early history of the Corliss engine are not yet forgotten by many who still survive.

Not only did Mr. Corliss invent a steam engine of new principle, but his effect upon the art of constructing steam engines in this country was equally marked. There is not more difference between a Waltham and a Waterbury watch than existed between the workmanship of a Corliss engine and the common steam engine of forty years ago. Engine manufactories of that time were generally coarse, crude, and unsystematic. Disorder, slovenliness, and dirt were their prevalent characteristics. The buildings were apt to be inconvenient, laid out at random, and such a thing as a thoroughly conceived and matured plan of manufacture was an unknown quantity. The Corliss plant stands to-day as a living evidence of the change wrought in steam-engine manufacture, and is a monument to the genius of a man only thirty years old when he created it—a man, be it remembered, never educated as an engineer or an architect, and never inside a machine shop until he was twenty-four years old. In the years following his invention the Corliss engine became the standard of excellence for workmanship throughout the United States. The best praise of an engine built elsewhere is to say, "it is as well built as a Corliss." The mammoth corporations of Lowell, the Blackstone Valley, and elsewhere depended implicitly upon the engineering judgment of Mr. Corliss to the last.

Pluck and daring were eminent engineering characteristics of Mr. Corliss. These were exhibited in such engines as those at the Merchants' Mill, in Fall River, when he startled the engineering world by a fly wheel thirty feet in diameter at the rate of a mile a minute. Experienced engineers quailed before such an experiment, but it was a success, and many similar engines are in daily use.

His engineering career has been one of bounding leaps beyond his competitors. The last great act of his life for the revolution of the art of building engines had drawn to completion at the moment of the close of his industrious life. For three years past, at the age when most men are glad to retire from active duty, he has been engaged in applying to the steam-engine manufacture the principles upon which guns and pistols are made. He has perfected an organisation of machinery by which three large engines can be turned out every ten hours; the components of the engines being perfectly interchangeable, precisely as are those of the weapons named.

CORRESPONDENCE.

We do not hold ourselves responsible for the opinions of our Correspondents.

POLLITT AND WIGZELL'S ENGINES.

To the Editor of "The Practical Engineer."

Sir,—I have to-day purchased for the first time your issue of "*The Practical Engineer*" for the current week, and am much interested in the discussion appearing therein respecting indicator diagrams. I have not seen the previous letters appearing upon the subject, and consequently am perhaps scarcely justified in offering any remarks. The subject is, however, instructive, and as your correspondent, Mr. Joseph Beaumont, has supplied indicator diagrams, it is to be presumed he is not afraid of having them criticised. As very little data is supplied by your correspondent, it is impossible to analyse the figures with absolute correctness, but when even a broad allowance has been made, the diagrams show that the power registered should have been considerably more for the quantity of steam used. With your permission I will examine the diagrams, both from the point of "cut-off," and also from the final pressure. It must, however, be borne in mind that in the absence of particulars as to clearance between piston and cylinder end areas of waste steam spaces, &c., this can only be done approximately. The steam appears to be cut off when the piston has travelled $\frac{1}{13}$ its stroke; boiler pressure 74lb. = say 89lb. initial pressure; capacities of cylinders, say, three to one. The terminal pressure in the low pressure cylinder should be $\frac{89}{13 \times 3} = 2{\cdot}28$lb. above zero. According to the scale given, the average terminal pressure is 6lb., which shows that a considerable amount of steam has entered the cylinder after the "cut-off" has apparently taken place. If the diagrams be worked from the "toe" of the figure (which averages, as above stated, 6lb.), the terminal pressure divided into the initial pressure, 89lb. = 14·833, the steam being subject to this number of expansions; the cylinders being three to one, the point of cut-off in high pressure cylinder should have been $\frac{1}{5}$ instead of $\frac{1}{13}$, and would thus have shown considerably more power for the same amount of steam used. Re-evaporation in the high pressure cylinder, and losses from radiation, &c., have, of course, not been taken into account in the above calculations, but they certainly would not account for the difference between the theoretical terminal and final pressures, and those registered on the indicator diagrams. The high pressure figures show leaky valves, but the actual loss is, of course, considerably arrested in the low pressure cylinder. Perhaps Mr. Beaumont might feel disposed to give further particulars as to the working of the engine with regard to the coal consumption, &c. The subject is instructive, and would be read with interest by many.

T. W. Hawkins.

[The stroke of the above engines is 66in., and not 56in., as stated last week.—Ed. *P. E.*]

To the Editor of "The Practical Engineer."

Sir,—I am pleased to see "J. W. J's" diagrams, and must admit that they show a great improvement after the application of the automatic expansion gear. But the cut-off is not instantaneous enough, and is not well defined. The expansion curve is rather full, which indicates a little wiredrawing. I may say the light load on the engine is in favour of giving a well defined cut-off, and if steam were carried longer on the stroke the diagrams would not be as good; but they are a great improvement over the old sluggish way of working.—Yours truly, R. B.

Bradford, April 2.

BRAKE TO PREVENT OVERWINDING.

To the Editor of "The Practical Engineer."

Sir,—I have read "A Practical Engineer's" letter in your last issue with respect to the above, and I am afraid that for the many misapprehensions contained in that letter I am somewhat to blame, having been too busy to forward further particulars. I must say that your correspondent's letter displays very little but what might have been kept quiet until a full description of the apparatus had been given, for had he done so his letter would have certainly never been written. In the first place I am not interested in the apparatus; in the second place the apparatus is in action some time before it reaches the pit top; in the third place a powerful brake is essential for the apparatus, whilst the merits of a properly balanced winding engine and convenient valve gear are so well known and valued that it is useless to waste space in dealing further with that portion of your correspondent's letter. I will, however, send you the full particulars at my earliest opportunity.—Yours faithfully,

March 30, 1888. Mining Engineer.

SMOKE CONSUMERS.

To the Editor of "The Practical Engineer."

Sir,—Referring to the letter of your correspondent, "An Old Offender," I entirely agree with his views that any of our institutions would be serving a most useful and valuable object by forcing to an experimental test a select few of the most efficient smoke consumers. It is now many years since any such trials were made, during which time the question of proper combustion and consequent prevention of smoke in steam boilers has been much traversed, and the means of attaining this object must of necessity be improved. Still, judging from the appearance of the great majority of our mill chimneys, there is evidently a most lamentable ignorance of a really effective arrangement of furnace for obtaining satisfactory combustion under ordinary working conditions, and as a consequence there is a large amount of valuable heat continually passing uselessly away into the atmosphere in the form of black smoke, and which constitutes a most disagreeable and reprehensible nuisance. This state of affairs does not reflect any credit on either furnace owners or engineers, and they should not be content until they have effectually remedied it. That this is within the limit of possibility has been proved by several smoke-consuming furnaces that have lately been brought before the public. With respect to the one mentioned by "An Old Offender," viz., the assistant draught furnace and smoke consumer manufactured by the Oldham Boilerworks Company, I have an intimate knowledge of its working results in different places where there are a number of boilers which are heavily fired, and where its practical efficiency in preventing the smoke nuisance is absolute. It is a simple arrangement of furnace, free from any complications of working parts, whilst its principle of securing an increased or assisted draught under the fire-bars and below the solid fuel, and supplying and effectively distributing a constant current of heated air to the gaseous fuel, renders combustion more instantaneous and complete, and less dependent, at all times, on the action of the chimney. There are, no doubt, other meritorious systems, and the result of a competitive trial of the best systems, by men whose capability and honesty are beyond question, would afford a most desirable and scientific gain to steam users and engineers.

Many of our institutions have funds, and will they not utilise them in carrying out so useful and practical an object?—Yours truly,

March 27th. Boiler Inspector.

TALLOW CUPS v. SIGHT-FEED LUBRICATORS.

To the Editor of "The Practical Engineer."

Sir,—Having made lubrication a special study for some years, practically as well as theoretically, I may be able to throw some light on the above subject. "Sight-Feed," in your issue of the 2nd inst., appears to be perfectly satisfied with his sight-feed lubricators, because he can see each drop of oil as it passes through the glass, and by examinations of pistons and valves. I will take his last reason first, and will say that finding the pistons and valves to his satisfaction is, in my opinion, no criterion, for this reason—the steam (especially if moist, which is the case I have no doubt in "Sight-Feed's," with a low boiler pressure) will keep them in good order. To convince him of it, I have engines at work now which have been at work for fourteen years with nothing but tallow cups on up to twelve months ago, which are in first-class order up to this date. As to the other reasons that "Sight-Feed" gives, I count them as nothing; he sees the drop of oil passing through the glass, but can he or any other man guarantee that it passes into the steam chest in the same order? I expected to see (and was not disappointed) a reply to 'Eureka" by "Sight-Feed," stating how much oil and fuel he had saved since he commenced to use sight-feed lubricators; on the contrary, he advises "Eureka" to purchase the most expensive lubricators and oil, which will give no better results than the tallow cups he has already in use. I would advise "Eureka," before spending the enormous sum it would require to purchase sight-feed lubricators, to try a couple, and if they do not reduce the consumption of fuel, I consider they are no better than his tallow cups. If lubricators are of any use, it is to reduce friction, thereby gaining power, or, in other words, less consumption of fuel. To do this I have done away with tallow cups, displacement, and other lubricators fixed to the steam chests of eighteen high-pressure engines under my control, and substituted a lubricator to each cylinder, which can be regulated to a nicety. I cannot give the exact saving in fuel, as we use steam from the same boilers for other purposes, but I have it from each of the enginemen that it does not take near so much steam to drive the engines now as it did previous to the lubricators being put on each cylinder, and that they will make three or four revolutions after steam is shut off, whereas before they would stop sudden, with a groan in the cylinders. I do not want to advertise these lubricators in this correspondence, but if "Eureka" is anxious to try them I will be pleased to give him the name through the medium of this journal.—Yours, &c.,

March 24th. Economy with Efficiency.

BOILER REGISTRY AND INSPECTION BILL.

To the Editor of "The Practical Engineer."

Sir,—"Public Interest's" letters have been read by many practical men, who don't agree with him at all—I for one, who am a working engineer more from hobby than anything else. I have been brought up among engines and boilers all my life, and would like to be examined for a certificate by the side of your correspondent, if practical work and not a severe examination in mathematics were to be the test. What would be the benefit of having compulsory examination for enginemen? it would better a few lucky men, but injure a great many. Take, for instance, a large works where a great number of enginemen are employed, at, say thirty shillings a week. The employers would look after a certificated man, and set on any labourer about the place under him to take charge of the engine and boilers. Would they be safe then because they have a man who has been examined, if he never saw the boilers from week end to week end? I admit it would be better where there is only one engineer in work, as it would be the means of raising his wages. But what form would the examination take, and what would be a competent man? I should contend that a competent practical man would be a man able to make a boiler or engine, one who could go to the blacksmith's shop and make anything he wants for repair; one who could bore out a cylinder, or turn up a valve and seat, and there are plenty of enginemen in the black country who can do this; but "Public Interest" seems to say he must be a man who gets a bit of waste in his hand and struts about like a turkey-cock, and says, "Look out, I've got a certificate for life; I am right. I am a competent man, because I have been examined in theory," in some place where an engine and boiler have never been seen perhaps. I quite agree with anything that will improve enginemen's condition; they work more hours, and have everybody to think about, and are thought less of as a rule than anybody else in a factory. If the bill passes, let the examination be in real practical work, in repairing, in saving of fuel, and in the safety of the boilers. Let the examination be with boilers and at boilers, not in some out-of-the-way office, by men, perhaps, who never went in a boiler in their life. In conclusion, I would like to ask "Public Interest" how many boilers blow up through ignorance, and what sort of a certificate would have saved the last Dudley explosion? If that was not examined by practical men, what was? I hope you will find room in your useful paper for these few lines from an illiterate Engine Labourer.

To the Editor of "The Practical Engineer."

Sir,—May I again be allowed a little space in your valuable paper for a few more remarks on this subject? First, I will try to answer Mr. Mosley, who, like some others, seems to be afraid of Board of Trade inspection. There are a great many enginemen who have been 20 years what they term stokers or enginemen, but if they were put to any other job than the one that they have been always at, they would find themselves deficient of a great deal that they ought to possess, and if they were tested the public would know what sort of men they were. But, as things are now, anybody who can handle a shovel calls himself an engineman, no matter how little he knows about the boilers or engines. According to your correspondent's statement, that doesn't matter as long as the boilers burn the coal and the engine keeps going round. I know a man who could not make a faced joint, in fact he could not clean the face, and I dare say he is not the only one. I don't think myself we require men with their papers, but still what is wanted is men who understand their work, and, while remembering that boilers have not been made to last for ever, I hold that if certified men are in charge of them, they will last longer than is now the case. As to the public interest being in the back ground, and the whole of humanity having to suffer through certificated enginemen, I wish your correspondent would explain more clearly what he means. "M. Y." finishes his letter by saying that he gets among engineers, and finds that Government inspection is most wanted, and if boilers were inspected by Government, that would be the cure. Sir, I should like to refer these two, and all others who wish to understand my proposals, to the *Engineer*, March 16th, 1888; then perhaps they will be satisfied, but no doubt they will be more afraid of inspection than ever. We do not find unqualified enginemen on railways very often; they have to understand their work before they can run a train to the seaside. Perhaps if they were like a great many stationary enginemen, they would take the train right into the sea.—I remain yours,

Leicester. Public Interest.

THICKNESS OF FLANGED PLATES.

To the Editor of "The Practical Engineer."

Sir,—I have no doubt that others as well as myself have experienced difficulty in gauging the thickness of flanged plates, where the only measurement obtainable is at the edge of flanging. I have certainly known very different thicknesses of the same plate to be given by different persons. The question of arriving at an approximation as to the actual thickness of plate is of importance where the strength of a flanged end plate requires to be calculated, or where a tube is reduced by corrosion, and where great accuracy is necessary the only satisfactory way is by drilling. The difficulty is, of course, increased by unevenness of workmanship, but, assuming that the flanging is moderately even, so that the average thickness at the edge may be fairly gauged, I take it that the thickness at the root and at the edge of the flanging will vary inversely as the circumferences, and consequently as the diameters. For instance, take a cross tube 10in. diameter, with flange 15in. diameter, and made from ⅜in. plate, the thickness at the outer edge of flanging would be reduced to ¼in. In a smaller tube the difference is more, and in a larger one it is less marked. In the case of a 3ft. tube, with flange 3ft. 6in. diameter, and made of $\frac{7}{16}$in. plate, the thickness at edge of flanging would be reduced to ⅜in. With machine flanging the case may be different, as I presume the thickness will be more even throughout, and will not vary at different parts of the flanging according to distance from root. Following the same rule in the case of flanged end plates, the order would be reversed, and the edge of flanging would be thicker than the other parts. Thus, with a 3ft. end plate, flanged out of a plate 3ft. 6in. diameter, the thickness would be increased as 6 to 7, or a ⅜in. plate to $\frac{7}{16}$in. at edge of flanging. Probably some of your contributors who are regularly engaged in such work, who see the plates flanged and know the actual thickness of the plate being used, may be able to throw some light on this subject. If any such would give the benefit of their experience as to the alterations in thickness from various kinds of flanges, it would, I believe, be appreciated by many.—Yours, &c., P. E.

QUERIES AND REPLIES.

Stress on a Rope.—Will any reader assist me to calculate the stress on a steel rope 4in. circumference, working on an engine bank, dipping 1½in. in 12 inches. Load 14 tons.—Student.

Answer.—Since the power drawing the rope up the incline twelve inches raises the load and rope one and a half inches, or the upward movement of the total lead is one-eighth of that of the moving power, so the statical balance of the total load on the inclined bank as sustained by the rope in tons is one-eighth of the total load, or is $\frac{\text{14 tons} + \text{weight of rope in tons}}{8}$

And the stress on the rope at work in lbs. $= \frac{14 \times 2240 + \text{weight of rope in lbs.}}{8}$ + friction in lbs. of the loaded wagons, the amount of which, of course, depends on the sort of wheels, axles, rails, &c., that are used. One yard of such rope will weigh about 7lb., and assuming the incline to be 200 yards long, and the friction of the wagons to be 16lb. per ton of load, we have for the stress $\frac{14 \times 2240 + 7 \times 200}{8} + 14 \times 16\text{lb.} = 4095\text{lb.} + 224\text{lb.} = 4319\text{lb.}$—W. A.

Cost-keeping.—Can any of your numerous readers recommend me to a good practical cost clerk, who can teach a reliable system of cost-keeping, not merely a theoretical system, but a practical one, involving the least labour to arrive at results?—R. H.

Answer.—I would recommend "R. H." to write to Mr. T. Middlebrook, late cost clerk to Thwaite Bros., Bradford, for particulars of his system of cost-keeping. He is the publisher of a set of sheets which are very good and reliable. I have seen examples of his every-day work. Address: T. Middlebrook, care of Messrs. Green and Nephew, engineers, Leeds.—Draughtsman.

Marine Engines.—Will some engineer kindly give me his opinion on the following matter? Assuming a compound marine engine, with cylinders of 46in. and 88in. by 4ft. 9in. stroke, 64 revolutions, boiler pressure 108lb., cut-off in h.-p. cylinder at ½ stroke, developing 3,300 i.h.p. on a coal consumption of 1·78lb. and 15lb. per square foot of grate, what would probably be the coal consumed and boiler pressure maintained to give similar power if the large cylinder only were worked.—Antipodes.

Answer.—As a basis on which to found some conclusions for answering his questions, "Antipodes" does not state whether he would use the steam expansively in his larger cylinder when worked alone, or whether he proposes to use it at the same constant pressure throughout the stroke: nor does he say anything of the capability of his boilers for producing any more steam than the compound engine requires for developing the 3300 h.p. named. We will, however, in the first place assume that the steam be used expansively, being cut off at one-eleventh of the stroke, in which case the same steam pressure and the same quantity of steam and fuel will be required to perform the same amount of work in the same time as in the case of the compound engine. We cannot, of course, say whether the materials used in the construction of the engine will be able to stand this great strain. Again, if we assume the steam to be cut off at one-fifth of the stroke, the required initial pressure on the piston to perform the same amount of work as stated above, will be 62½lb. per square inch, and the weight of steam required will be 1·34 times the weight of the steam required by the compound engine. As the coal consumed in the furnaces is only 15lb. per square foot per hour, perhaps the combustion might be urged up to 22lb. or 23lb. per square foot per hour, in which case sufficient steam might be produced to drive the engine up to the full power as above, with a probable coal consumption of 2⅜lb, per horse power per hour. But, as stated above, we do not know that the strength of the materials used in making the engine will be able to stand the above strain of 62½lb. to the square inch with safety. And again, if we now assume there to be sufficient steam produced and admitted at full pressure on the piston throughout the stroke, the amount of the pressure required will be about 32½lb. per square inch, and the steam used in the same time while performing the same amount of work will be 3⅜ times the amount used by the compound engine—an amount which we may presume to be utterly beyond the power of production by the boilers used in connection with such compound engine as named above. And if sufficient boiler power were applied in order to produce such quantity of steam as stated above, the corresponding coal consumption would be about 6¼lb. per horse power per hour. The strength of the materials forming the engine would in this case be sufficient to withstand the strain if they were sufficient for that purpose when compounded.—W. A.

Propeller.—What will be the angle at the root and point of a propeller blade, 4ft. 2in. diam., 7ft. 8in. pitch, 11½ diam. of boss, by formula or diagram? Also, is it at the widest part of the blade that takes the angle to find the pitch when propeller is in dry dock?—Alpha.

Answer.—In answer to "Alpha," as to angle of the blade of a propeller—

Let p = the pitch of the propeller.

r = the radius of the arc described by any point P in the propeller blade.

ϕ = the angle of inclination of the surface of the propeller blade at point P, with a plane perpendicular to the axis of the propeller.

Then $\text{Tan}\ \phi = \frac{p}{2\,r\,\pi}$ (1) And $p = 2\,r\,\pi\ \text{Tan}\ \phi$ (2) When $2\,r = 50$ inches and $p = 92$ inches. $\text{Tan}\ \phi = \frac{92}{50 \times 3{\cdot}1416} = 0{\cdot}5857$ or $\phi = 30^{0}{\cdot}21^{1}$, angle at point of propeller.

When $2\,r = 11\frac{1}{2}$ inches, and $p = 92$ inches. $\text{Tan}\ \phi = \frac{92}{11\frac{1}{2} \times 3{\cdot}1416} = 2{\cdot}5464$ or $\phi = 68^{0}{\cdot}33^{1}$, angle at root of propeller.

The pitch may be determined by help of formula (2) from any point of the propeller blade by taking the value of r and the angle ϕ at that point.—W. A.

Steel Castings.—Would any of your readers give me any information as to the theory of moulding and casting the above? Also if there is any work published on the subject?—Moulder.

Answer.—There is no work published on the subject of steel moulding and casting. If "Moulder" will write to me, I will give him the information he requires from practical experience.—T. C. Hutchinson, 15, Hill Street, Middlesboro'-on-Tees.

Could any reader inform me how I am to make the following: I want some aluminium tubes about 1½in. diameter, $\frac{1}{16}$in. thick, and about 1½in. long, with flanges on the end. Can I buy the tubes ready made and solder the flanges on, or should I have to get sheet metal, and bend it over, and solder it up all along to make them? What would be the best kind of solder? Is aluminium very expensive, and who manufactures it?—W. Ll. P. W.

Answer.—I should advise "W. Ll. P.W.," for accuracy, to make the tubes with press tools—one pair of tools for cutting blanks and another for the bending of flange over. The blanks would have to go through rollers such as tinners use, and thence to the bending tools, which process would leave the tubes in an almost finished state. Shall be glad to furnish him full particulars if required.—W. Pickard, Oldham.

Twiner Spindles.—How many twiner mule spindles are reckoned to the horse power?—Inquirer.

Illuminating Paint.—I should be glad to have the address of a maker of illuminating paint.—S. C.

Electro-plating.—Could any reader kindly inform me how I best could re-electro.plate a tricycle? The cheapest and simplest style will oblige.—Club Tandem.

Twist Drills.—Can any reader give me any information regarding these? Are they milled? If so, how? Is cutter arranged to get the under-cut? How are they ground for clearance? Could they be cut in a lathe?—A. R.

Designing Engine Cylinder.—I intend making a steam engine, 3in. bore, 6in. stroke. Would some one kindly show me how to find the size of posts, and thickness of material, cylinder and steam chest (ordinary cast iron); also length of connecting rod?—Bolt.

Steel Plates.—Will some reader kindly give me a list of lengths and widths of iron and steel plates kept in stock by most merchants. What I want is to be able to design tanks, boilers, &c., without having to get them cut, as this increases the labour, and does not add anything to the strength.—H.L.C.

Electric Batteries.—(1) Would any one alone of the following cells—Danniell's, Leclanché, or bichromate—be strong enough to decompose acidulated water? If not, how many would be needed in series? (2) How many of either kind—Danniell's, Leclanché, or bichromate—would be needed to light and maintain a small glow lamp, say of 6 c.p., and how should they be arranged? and (3) would a Danniell's cell work connected to a bichromate or a Leclanché celll, or *vice versa*?—Volt.

Regulating Engines.—Will some of your readers kindly give me their experience as to the best arrangement for regulating an engine with constantly varying and extreme loads; *i.e.*, whether to apply sensitive governor to throttle or to variable cut-off gear. The particular engine I have in view has slide valve with cut-off plates on back, and boiler pressure of 70lb.—X.Y.Z.

TO CORRESPONDENTS.

J. Hamilton.—The Official Journal of the Patent Office is now issued weekly; it is not illustrated. There is, however, an illustrated journal of patented inventions, also issued weekly, which contains an abridgment, with illustrations in most cases, of complete specifications accepted.

Old Working Engineer.—Communication received, but not inserted for want of room.

R. S. T.—Apply to J. Wild, machinists' engineer, Chadderton, near Oldham.

T. C. J.—Seaton's book deals principally with the design and construction of engines and boilers, and not so much with their actual management. Read the articles appearing in this journal from time to time.

F. C.—The clearance can only be calculated in one way, viz., by measurement of the ports and of that portion of the cylinder not traversed by the piston.

Governors.—You will find a brief account of several marine governors in Seaton's work on Marine Engineering; the book, however, is rather expensive, and would not be worth while purchasing unless you require it for other information as well.

Working Man.—Consult Unwin's book on Machine Design.

Harris.—The expression simply means the cube root of the square of the quantity involved.

MISCELLANEA.

Tool-grinding Rest.—A patent tool-grinding rest has just been brought out by Messrs. Syer and Co., 21, Finsbury Street, London, E.C., which is very simple and efficient. It can be fixed at any desired slope, and the angle can be obtained at any time after examining the edge of the tool being ground.

Train Heating in France.—A French railroad is trying the experiment of heating passenger cars with gas. Cylinders containing gas are carried on the roofs of cars. The gas is passed through petroleum, and then burned in metal tubes running along the base of the compartments. The results of the experiments that have been made are said to be quite satisfactory.

The Nile.—The Nile, which was launched at Pembroke Dockyard last week, is the heaviest ship of war ever launched in this country. Her weight is 6,700 tons, giving a pressure of about 2·64 tons per square foot upon the comparatively narrow ways. The gradient of the slide down which the ship moved was $\frac{13}{16}$in. to the foot. The vessel has been advanced, since she was first begun, at the rate of 61·7 tons per week, at a cost of £14 per ton.

North-East Coast Institution of Engineers and Shipbuilders.—The next meeting of this society will be held on Wednesday at 7-30 a.m. in the lecture hall of the Literary and Philosophical Society, Newcastle-on-Tyne, when the adjourned discussion on Mr. J. T. Milton's and Mr. G. W. Sivewright's papers on "Slide Valve Gears" and "Stockless Anchors" respectively will be taken. A paper will also be read on "The Construction of Pontoon Dry Docks," by Mr. A. Taylor.

A Submerged Forest.—During the late violent storms in the Channel the sea washed through a high and hard sand-bank near St. Malo, nearly four metres thick, laying bare a large portion of an ancient forest which was already passing into the condition of coal. This forest at the beginning of our era covered an extensive tract of the coast; but with the sinking of the land it became submerged and covered up by the drifting sand. Mount Saint Michel once stood in the middle of it.

The North Baltic Canal.—Information has been received at the Foreign Office from Her Majesty's Consul-General at Hamburg that the Imperial North Sea and Baltic Canal Commission have invited tenders for the supply of two steam dredgers and seven steam barges for use in the construction of the North Baltic Canal. The conditions of tender can be obtained upon payment of two marks in cash, or by postal order (stamps not accepted), to the Imperial Canal Committee, No. 61, Muhliusstrasse, Hamburg.

Steam Brake.—A new American steam-driver brake for locomotives is operated by a button on the foot-board of cab, where the dirver can easily reach it with his foot. It will apply the brake to drivers only, to drivers and tender, or to tender alone, at will. The steam releases as well as applies the brake, and is held on till the automatic on train is fully released and the train is free; then the steam brake is thrown off, and train starts easier. A gauge attached to the brake cylinder shows how much pressure is being used on the drivers.

Electricity on the Stage.—A royal decree was published in Madrid on Saturday making it obligatory on managers of theatres to light those buildings by electricity, to the total exclusion of gas. Six months are allowed in which to carry out this most important reform. All dynamos, engines and motors of any kind, are to be completely isolated from the main building, and minute rules are laid down for their safe installation. The supplementary lights are to be oil lamps. Persons employed behind the scenes are prohibited from using unprotected lights.

Injectors.—We learn that Messrs. Holden and Brooke, Limited, of St. Simon's Works, Salford, Manchester, have secured the services of the injector manager, foreman, and some of the workmen recently employed by Messrs. Sharp, Stewart, and Co., who, on their removal to Glasgow, are discontinuing the manufacture of live and exhaust steam injectors. Messrs. Holden and Brooke are consequently now supplying exact duplicates of the Giffard, Atlas, Friedman's, and other injectors recently made by Messrs. Sharp, Stewart, and Co., and they will, of course, continue as hitherto the manufacture of their patent exhaust steam, patent influx automatic, and other injectors.

The Hull and Barnsley and Midland Railway Companies.—As the time draws near for a Committee of the House of Lords taking up the bill for the transfer of the Hull and Barnsley line to the Midland Company, the opposition to it has increased. The principal ground of opposition will be directed against the powers the Midland require to arrange with the North-Eastern and other companies with respect to the mineral and other traffic. The Hull and Barnsley Company since the completion of their line have reduced the rate for coal sent from South Yorkshire to Hull from 3s. 1d. to 2s. 7d. per ton, with the result that there has been an increase in the quantity sent to the chief Humber port from 1,302,000 tons in 1884 to 1,791,000 tons in 1887—an increase of nearly 43 per cent.

SELECTED PATENTS.

APPLICATIONS FOR LETTERS PATENT.

March 21st.

4355 Pulleys, C. F. Clark, of the firm of T. and C. Clark and Co., London.
4358 Hydraulic Lifts, H. C. Walker, London. (N. Selfe, New South Wales.)
4362 Bronzing Machines, H. Shilton and H. May, London.
4363 Moulds for Casting Pipes, K. Thien, London.—[Complete Specification.]

March 22nd.

4371 Water Taps, W. Shelley, Brighton.
4381 Wagon Couplings, J. Maxwell, Edinburgh.
4384 Taps, H. W. Swift, Ince, near Wigan.
4397 Brakes, D. Nicoll, Westminster.
4409 Ventilators, C. Brothers, London.
4413 Producing Marbled or Grained Surface on Cast Iron, B. B. Lee and T. S. Neale, London.
4427 Miners' Safety Lamps, E. Edwards, London. (C. A. T. Merlin, Belgium.)
4428 Lubricators, E. Edwards, London. (W. Elsner-Bourgeois, Switzerland.)
4430 Treatment of Metallic Ores, G. J. Atkins, London.
4431 Ball Valves, F. J. Henderson, London.—[Complete Specification.]
4432 Lifting Jacks, J. P. Cito and P. Funck, London.—[Complete Specification.]
4435 Rolling Mills, A. Zdziarski, London.—[Complete Specification.]

March 23rd.

4450 Valves, F. Barber, Sheffield. (P. Barclay, Boston, U.S.A.)
4452 Cranes, T. F. Smith, Halifax.
4462 Sleepers, A. T. G. Brown, Middlesex.
4464 Anchor, E. J. C. Fear, Bristol. (R. S. Munn, Newfoundland.)—[Complete Specification.]
4466 Valve, J. Sykes and T. Cook, Huddersfield.
4468 Lubricators, G. H. Felt and W. O. Felt, London.
4480 Propulsion of Ships, A. W. F. G. Linnenbrügge, London.—[Complete Specification.]
4485 Extraction of Gold and Silver from Ores, F. Maddick and J. Greenwood, London.
4488 Dredging Apparatus, A. E. Rugeroni, London.
4491 Safety Lamps, E. Edwards, London. (A. M. Verschuren, Belgium.)
4493 Ventilators, J. W. Sizer and A. L. Sizer, London.

March 24th.

4499 Screw Propellers, G. Cadenhead, Glasgow.
4500 Injectors, E. W. Jones, Great Yarmouth.
4515 Gas Motor Engine, H. J. Warsop, Nottingham.
4517 Pipe for Heating Apparatus, S. P. Rushworth, Yorkshire.
4524 Galvanic Batteries, W. J. S. Barber-Starkey, Manchester
4525 Endless Band Saw Machines, F. Parker, Manchester.
4527 Warming Railway Carriages, J. Morris, Surrey.
4531 Motive-power Engines, J. Bourne, London.
4539 Pumps, F. Correa, London.
4551 Saw-setting Machines, R. Haddon, London. (A. Titscher, Austria.)
4559 Electric Arc Lamps, F. de Wolffers, London.
4560 Railway Signalling Apparatus, J. P. O'Donnell, New Malden.

March 26th.

4569 Safety Trap (Gas), J. S. Garthwaite, Gateshead-on-Tyne.
4570 Accelerating Air Draught, A. Howarth and E. Horrocks, Heywood.
4575 Warming Railway Carriages, J. Milnes, Huddersfield.
4590 Prevention of Incrustation in Steam Boilers, R. A. Dent, Sheffield.
4599 Ratchet Drill Brace, W. H. Day and H. Ward, Isle of Wight.
4601 Dredgers, H. Vering, London.
4602 Heating Tube for Furnaces, H. Tilden, Minnesota.—[Complete Specification.]
4606 Motive Power, A. Fehlen, of the firm of W. G. MacIvy, London.
4615 Valve Gear, B. Sjövall, London.
4618 Weighing Apparatus, W. B. Avery, London.
4621 Type Writers, A. J. Boult, Middlesex. (A. Downey, Canada.)
4624 Valve Gear, F. W. Crossley, London.
4626 Electrolytic Production of Metals, C. Hoepfner, London.
4629 Valve Tap, W. D. Godson, London.
4630 Packing for Pistons, H. E. Daniell, London.
4633 Valves, S. Tommis and A. E. Whitwham, Huddersfield.
4637 Utilising Waste Heat, C. Tellier, London.—[Complete Specification.]

March 27th.

4642 Ball Valves, A. C. Bell, Bexley Heath.
4651 Hot Water Circulating Boilers, D. Horrocks, Manchester.
4661 Smoke Consumer, R. Shackleton, Bradford.
4662 Heating Feed Water for Steam Boilers, R. Shackleton, Bradford.
4667 Flange Joints, A. Mechan, Glasgow.
4670 Ships' Buffers, G. B. Richards, London.
4672 Ventilator, J. Troop, London.
4677 Vapour Condenser, R. Reichling, London.
4679 Coating Metallic Tubes, W. Clark and W. Reid, of the firm of W. Reid and Co., London.
4680 Flue Tubes for Steam Boilers, W. Clark and W. Reid, of the firm of W. Reid and Co., London.
4681 Machinery for Pulverising Ore, H. H. Eames, London.—[Complete Specification.]
4689 Condensing Fluids, A. Rathbone, London.
4697 Stopcocks, R. L. Howard, E. Howard, and R. S. Lloyd, London.
4698 Centrifugal Machines, W. Bergh, London.
4719 Registering Vacuum Condensing Engines, S. Gerry, Devonshire, and J. W. Donovan, Sunderland.

March 28th.

4724 Ball Valve, I. Barnsley and I. J. Barnsley, Sheffield.
4729 Type-writing Machine, E. J. Arnold, London.
4733 Heating Feed Water in Boilers, A. MacLaine, Belfast.
4735 Vices, C. R. Walder, Manchester.—[Complete Specification.]
4740 Motor Engines, C. Ridealgh and C. J. Fairman, Newcastle-on-Tyne.
4763 Car Couplings, H. Dede, London.
4769 A Heater for Railway Carriages, F. Radelet, London,

March 29th.

4778 Machinery for Straightening Circular Saw Plates, W. H. Walker, Sheffield.
4789 Governing Gear, C. H. Benton, London.
4800 Railway Coupling, W. James, Newcastle-on-Tyne.
4803 Explosive Matters in Motive-power Engines, E. Fox, London.
4812 Motive-power Engines, James Murrie, Glasgow.
4821 Rotary Engines, J. P. H. Gastrell, London.
4829 Wire-netting Machines, F. A. Wilmott and J. Wilmott, Middlasex.—[Complete Specification.]

NOTICE TO NEWSAGENTS AND SUBSCRIBERS.

Numerous complaints having been made to us by Subscribers of the difficulty they experience in obtaining copies of the *Practical Engineer* in certain districts, we have to state that the Journal can be obtained by any Newsagent through the ordinary trade channels, and no difficulty should therefore exist in obtaining copies by order of any Newsagent.

For the information of the trade, we may state that copies can be obtained from either of our Offices in London or Manchester, or from any of the following wholesale houses.

W. H. SMITH & SON, Strand, London.
W. H. SMITH & SON, Blackfriars Street, Manchester.
JOHN HEYWOOD, Deansgate, Manchester.
ABEL HEYWOOD & SON, Oldham Street, Manchester.
J. MENZIES & CO., Hanover Street, Edinburgh.
J. MENZIES & CO., Drury Street, Glasgow.
W. LOVE, 236, Argyle Street, Glasgow.
W. H. CLOUGH, Well Street, Bradford, Yorks.
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EDITORIAL NOTICES.

All communications for the Editor of this Journal should be addressed to 6, Victoria Station Approach, Manchester.

Communications intended for insertion in the current week's issue should reach us not later than Tuesday Evening.

We cannot undertake to return rejected manuscripts or drawings unless accompanied by a stamped and directed envelope.

Contributors are requested to write on one side only of the paper. Sketches should be sent on separate sheets.

TO ADVERTISERS.

Advertisements intended for insertion in the current issue should reach us on Wednesday morning at the latest.

Important Notice to Newsagents and Subscribers.

Our Publishing Offices in London are now at 11, PATERNOSTER BUILDINGS, E.C., where the Trade will in future be supplied.

Simultaneously with the above change, our PUBLISHING OFFICES in MANCHESTER have been REMOVED from Grosvenor Chambers, Deansgate to more commodious and convenient premises at 6, VICTORIA STATION APPROACH, where all communications intended for the Manager or Editor should, in future, be addressed.

THE
PRACTICAL ENGINEER.
APRIL 13TH, 1888.

THE ARCHITECTS' REGISTRATION BILL.

THE bill which has been introduced into the House of Commons, "to arrange for the qualification and registration of architects, engineers, and surveyors," was set down for second reading on Wednesday, April 11th, so that by the time this is in the hands of our readers it will have been discussed and its fate probably decided, although too late for the result to be noticed in the present issue.

It would appear from the preamble of the bill that its promoters consider it expedient that persons requiring professional aid in architecture, civil engineering, or surveying should be enabled to distinguish qualified from unqualified practitioners, and it is proposed to enact a system of registration for persons now practising the professions, and that in future only such persons shall be registered who are found to be qualified by examination. In other words, it is proposed to give a legal professional status to those at present practising the professions referred to, and to place difficulties in the way of any others wishing to become recognised as members in the future, by compelling them to pass some kind of examination or to undergo some prescribed course of training. In the professions of medicine and law only those who have been duly trained and qualified as lawyers and doctors are allowed to practise, and the idea of the promoters of the Architects' Registration Bill appears to be to place the professions of architect, engineer, or surveyor on a similar footing, and to prohibit anyone from practising who has not undergone a prescribed course of training and become duly qualified by examination.

One would naturally suppose that a proposition of this kind would be supported and appreciated by those whom it would appear to be principally intended to benefit, viz., architects, engineers, and surveyors themselves; but if the scheme were intended for the benefit of these, it has received but scant encouragement from some of those who might be considered to be most interested.

Instances have, no doubt, occurred where disaster and loss have resulted owing to the advice having been sought of so-called engineers and others who have not been duly qualified, either by training or experience, to advise as to the carrying out of important undertakings; but it should not be difficult, as a rule, to distinguish engineering quacks of this description from respectable and competent engineers, &c., and where, for the sake of apparent cheapness, the designing or carrying out of important work has been entrusted to inexperienced and unknown parties, in preference to engineers of known ability and experience, not much sympathy need be wasted for those whose niggardliness principally has led them into misfortune thus brought about.

One would naturally suppose that if any legislation of the character proposed were necessary, those most interested, viz., the engineers, architects, surveyors, &c., whose professional position it is sought to safeguard, and to whom the bill proposes to give a legal status, would be to the fore in urging it. As a matter of fact, however, those who may be considered as amongst the best qualified in the professions concerned not only do not consider such legislation necessary, but we find that the Council of the Institution of Mechanical Engineers, who have had the proposed bill under consideration, are of opinion that, if it should become law, it "would prove seriously detrimental to the interests of mechanical engineers generally, as well as to all other interests which are in any way connected with the progress of mechanical engineering, science, and practice."

The Council has gone so far as to prepare a "statement against the second reading of the bill," which has been duly printed and sent to every member of the Institution of Mechanical Engineers, with a request that each one will support by every means in his power the opposition against the bill, and particularly urging members to write at once to their borough or county member of Parliament urging him to oppose the second reading, set down for the 11th instant.

In this "statement" it is pointed out that mechanical engineering differs widely, both as regards education and qualification, from the other divisions of the profession, and the Council submit that the bill is not founded upon any public requirement; and, further, that a system of compulsory registration and examination for mechanical engineers would be injurious to the interests of mechanical science. Although the bill deals only with civil engineers, it is assumed that this description is intended to include all branches of the engineering profession except that of military engineering.

It is very properly pointed out in the "statement" that the Institution of Mechanical Engineers has numbered amongst its presidents George Stephenson (who was the first), his son Robert, Sir William Fairbairn, and other eminent mechanical engineers, most of whom rose from the ranks to achieve, by their own force of character, a world-wide reputation as mechanical engineers; and many of these rough, untutored geniuses would have been debarred from so rising had they been hampered at the outset of their career by such restrictive requirements as are contemplated in the bill. The members of the Institution number over 1,500, whose qualifications for membership have been approved by the Council previously to their names being included in the ballot lists for their election; and a large number of these have, like so many of the presidents of the Institution, risen to their present position from circumstances under which the system of examinations and registration proposed by the bill would have put an early stop to their career. The science of mechanical engineering is closely connected with every manufacturing industry in the country. A large number of mechanical engineers are directly engaged in manufactures, and the large works throughout the country are continually attracting to their service men educated and fully qualified as mechanical engineers. All these now retain the title of engineer, and through their connection with the Institution of Mechanical Engineers contribute materially to the progress of mechanical science. The bill would compel them to register as practitioners, under pain of losing their professional status or becoming subject to penalties, and the Council considers that this would be as impolitic as unjust. The statement concludes by saying that, on account of the foregoing and other objectionable features of the bill, the Council of the Institution of Mechanical Engineers trust that it may not receive the sanction of Parliament.

Proposals to create a monopoly, or a close corporation, for the benefit of any particular trade or profession, are very properly regarded with suspicion by the general public. There is a sufficient amount of the spirit of trades unionism in most professions, and it is satisfactory to find that a body like the Institution of Mechanical Engineers are capable of speaking out in so unmistakable a voice when a proposal is made which would have the effect of "protecting" their profession to a more or less extent. Engineers, architects, and surveyors may be trusted to look after their own interests, and when those whose interest it might be supposed were more particularly affected by this bill express themselves in so outspoken a manner respecting it, it should not be a difficult thing to prophesy what will be the probable fate of the bill.

High Pressure.—The new engines of the Boston and Albany Railroad carry 175lb. steam. This is the same as that carried for a long time by the London and North-Western compounds.

NOTES.

The Corporation of Birmingham is about to institute an entirely new departure in the sale of gas, by the use of "pay before delivery" meters. A number of prepayment meters (says *Industries*), constructed after the principle of the common automatic supply machines, have been offered by inventors; and a trial of one devised by Mr. Brownhills is to be made in a court of small houses. One or more pennies are dropped into an opening, and the regulating apparatus of the meter liberates a quantity of gas of corresponding value, after which it stops, awaiting the advent of fresh pence. The coins accumulate in a locked receptacle, and are removed by the collector at intervals. The mechanical arrangements of the meter will, it is believed, render fraud difficult; and they can be manufactured for about 20s. each.

A very large Corliss engine has been recently built by Messrs. Douglas and Grant, of Kirkcaldy, for an Indian firm of spinners and manufacturers. The engine, which will develop 2,500 indicated horse power, has two cylinders 40in. and 70in. diameter, with a 6ft. stroke, making 60 revolutions per minute. The flywheel is 8ft. 6in. wide, grooved for 38 ropes, and is 30ft. diameter. so that the velocity of the ropes will be over a mile a minute. This wheel weighs about 110 tons. The crank shaft is made from Whitworth's fluid compressed steel, 25in. diameter in the body and 20in. in the necks. The steam pressure will be 100lb.

Speaking in the House of Commons, last week, on the question of the housing of the national science collection, Sir Henry Roscoe said a great deal had been talked about our failing industries, and a great deal had been heard about protecting those industries; but he would venture to say that the one mode which all were agreed would lead to the protection of our industries was the development of the scientific education of the people. The present condition of things was a disgrace to the nation. When they heard of a small country like Switzerland spending £70,000 or £80,000 in erecting a single building, he thought it was high time that we should turn round and put our house in order, so far as the housing of this scientific collection was concerned.

LITERATURE.

Spon's Engineers' Price-book. London: E. and F. N. Spon.

Consulting engineers and others engaged in the work of estimating usually make their own pocket books of data and information respecting cost of labour and materials as they acquire the knowledge in the prosecution of their work. Busy men, however, have not always the time to do this sort of work, and younger men have not had the necessary experience, so that for these two classes at least a book such as the one before us will prove very valuable, containing, as it does, results of the accumulation of years of professional experience. The book commences with extracts from the Board of Trade Instructions to Surveyors, and from Lloyd's rules for the survey of machinery and boilers of steamships, and includes such matters as the rules for fixing the working pressure, rules for stays, flat surfaces, tube plates, furnaces, safety valves, riveted joints, shafting, girders, &c. Some data will also be found respecting three cylinder marine engines, and the speed of ships, besides an example of a specification of a triple expansion marine engine and boilers. Next comes the matter to which the book is specially devoted, beginning with the detailed cost of the hull of a steamship, and followed by that of the engines and boilers, and two tables of the entire cost of two paddle steam tugs. Then we have some jobbing rates and engineers' piecework prices, but we think these will not be universally applicable, as they are apparently based on the rates paid in the

Clyde district, which are very different to those paid say in Manchester. There are some very useful notes on the net cost of castings, time and materials, which includes such castings as a sole plate, cylinder, column, ram, propeller, and rope pulley. The author then gives a list of iron shipbuilders' rates and locomotive piecework prices. The second part of the volume deals with prices, and is very comprehensive in the number and variety of articles mentioned. A useful list of the patents, designs, and trade-mark rates in the various countries of the world, and a complete list of the members of the best known engineering societies in our country, bring the work to a conclusion. We are glad to note that the publishers have not forgotten to provide a very full index to the contents of the volume.

PNEUMATIC POWER TOOL FOR HAND USE.

An exceedingly ingenious pneumatic power tool has been recently introduced into this country from America, which promises to revolutionise much of the work in carving and dressing stone and other materials that is at present done by hand. The tool is held by the workman, and is simply guided over the face of the work, in much the same way as a hand chisel, and the enormously rapid blows given to it are effective in reducing the material operated on. The tool is worked by compressed air, at varying pressures, according to the nature of the work to be done; for instance, 30lb. would be a suitable pressure for cutting stone, while for chipping iron or caulking 45lb. to 50lb. would be required. The tool consists of a piston, working in a cylinder, and is driven backwards and forwards, by means of air pressure, at an enormous rate, stated to be 20,000 strokes a minute with medium pressures. The piston contains a valve, which is moved by the air at certain periods of the stroke, and which turns the current first to one end of the cylinder and then to the other, thus producing the oscillating motion of the piston. The piston does not accurately fit the cylinder, but there is about a thousandth of an inch play, which space is filled by the air, and hence the cylinder really floats in the air, and moves with scarcely any friction; were it not for this provision, the enormous speed mentioned above could not be reached, and the parts would wear out very rapidly. The stroke varies from a sixteenth to an eighth of an inch. The actual cutting tool itself is attached to a second piston placed in front of the one described above, and is kept up to its work by means of a spring. This spring in reality measures the pressure put on the work by the operator. The rapid impact of the first piston against the second one holding the cutting tool gives the latter the necessary power for chipping; but we should mention that the two pistons are always separated by a film of compressed air, in proof of which may be mentioned the fact that the faces of the pistons show little or no wear after being in action for a considerable time. The great advantage of the tool is that it admits of the workman using it with the same delicacy of touch as an ordinary hand chisel can be used, and hence for carving it should prove most invaluable. We may, on a future occasion, give a fuller description of this exceedingly interesting tool, along with drawings showing its construction. The British Pneumatic Tool Company, Limited, 10, Corporation Street, Manchester, has been formed for working the English patents, and their policy is to let the tools out at a fixed charge per month, instead of selling them outright.

JOURNAL LUBRICATION.

The waste of power, loss of time, and risk incurred by hot boxes cannot be easily put into exact figures; but it is evident that it is worth while to incur considerable expense if hot boxes can thereby be avoided. Much importance is usually laid upon the bearing metal being of good quality, and this is no doubt a very important factor. It cannot, however, be maintained that the use of expensive bearing metal will unaided secure satisfactory results.

The great variety of materials used with success in different bearing alloys shows that many diverse metals and alloys will wear well and run cool, and the hot boxes cannot be avoided by merely using one particular bearing metal. A hard compound of copper and tin with a minimum quantity of zinc is often considered the best bearing metal, but in marine practice a metal almost composed of zinc is very largely used. The recipes for so-called Babbitt metal differ very widely, lead and zinc being largely used in some cases, and tin and antimony in other mixtures, while the difference in the behaviour of these alloys is not always in direct proportion to their cost.

A journal box or other bearing will only run cool when all of several conditions are observed:

1. The wearing surfaces must be sufficient.
2. The wearing surfaces must be smooth, have a uniform bearing, and be provided with oil ways which will evenly distribute the lubricant.
3. Dust must be excluded.
4. The lubrication must be constant, and must not be suspended by leakage, hot or cold weather, a slight heating of the bearing, or the effect of rapid motion on the means by which the lubricant is fed to the bearing surfaces.

It can hardly be maintained that the present crude form of journal box fulfils these conditions. The bearing surface is not sufficient for the present heavy cars run at a high speed for long distances without stopping; dust is not excluded; leakage is not prevented; the supply of lubricant is uncertain, and is affected by many extraneous causes; whilst the method by which the lubricant is conveyed to the journal is not only inefficient for its purpose, but is in itself a very frequent cause of heating. A clod iron axle is particularly apt to catch up threads of waste and wedge them under the brass, one of the most frequent causes of heating.—*Railroad Gazette.*

BOILER EXPLOSIONS IN THE UNITED STATES.

The *Locomotive* for February gives its usual summary and classified list of boiler explosions for the year 1887. The total number of explosions was 198; in many cases more than one boiler exploded, but it is reported as one explosion.

The number of persons instantly killed, or so badly injured that they died within a very short time after the accident, was 264; the number injured, many of whom were stated by the reports to be fatally injured, was 388, or a grand total of 652 persons killed and badly hurt. This is a showing of which the people of the country at large are not, in all probability, proud The figures in detail are given in the accompanying table:—

	Class of Boiler.	
1	Sawmills and other wood-working establishments...	73
2	Locomotives..	14
3	Steamships, tugs, and other steam vessels	14
4	Portable boilers, hoisters, and agricultural engines...	20
5	Mines, oil wells, collieries	13
6	Paper mills, bleacheries, digesters, &c.	5
7	Rolling mills and ironworks	15
8	Distilleries, breweries, dyeworks, sugar houses, and rendering works	9
9	Flour mills and grain elevators	7
10	Textile manufactories	1
11	Miscellaneous	27
	Total........	198

Nearly 37 per cent of the whole number of explosions were, as usual, furnished by the lively saw mill boiler. Portable boilers, oisters, and agricultural boilers come next, but their number was but little more than one-fourth of those occurring in sawmills. Rolling mills come next with fifteen, while locomotives and steam vessels are tied for fourth place. The other classes furnish about the usual number of explosions.

The explosions of the past year do not appear to have been more than usually destructive, or to have killed or injured more than the usual number of people. The whole number reported killed foots up 264, against 254 in 1886, while the injured are 388 compared with 314 the previous year, the increase being in about the same ratio that the number of explosions reported have increased.

KEEP'S TESTS FOR FOUNDRY IRON.

A paper has recently been communicated to the South Staffordshire Institute of Iron and Steel Works Managers by Professor T. Turner, of Mason College, Birmingham, giving a full account of the methods of testing cast iron devised by Mr. W. J. Keep, of the Michigan Stove Company, Detroit, U.S.A. These tests have been adopted by a number of important American firms who have to do with the buying and selling of foundry iron, and it is sought to introduce them into this country, for the purpose of providing a uniform standard, which has already been approved by a lengthened experience in America. When the tests are carried out in their entirety, 15lb. of metal are melted in a plumbago crucible in a firebrick furnace driven by a blast at a pressure of 2½oz. per square inch. Three sets of test bars are run from each melting. One bar is ½in. square, and is cast with the ends against a chill exactly 12⅛in. apart. Another bar is cast with this, and is run from the same gate. It is 1in. wide and $\frac{1}{10}$in. thick, and is run against chills in the same way as the square bar. When the bars have been trimmed, and both bars and chills have attained the same temperature, the shrinkage is measured by inserting a graduated wedge between the end of each bar and its chill. A third bar is called the fluid strip. The pattern of this is 1in. wide, 12in. long, and $\frac{6}{100}$in. in thickness. This is run from the end, and is poured first. The strip rarely runs full, and its length in inches is taken as a measure of the fluidity of the metal. The fourth bar is called the crook strip. It is 12in. long, 1in. wide, and $\frac{86}{1000}$in. in thickness. On the centre of one side there is a rib $\frac{412}{1000}$in. high, ⅕in. wide at the base, and $\frac{1}{10}$in. wide at the top. The unequal shrinkage of the thin flat strip and of the taper rib causes a slight curve in the test piece. This, when measured, affords valuable information as to the properties of the iron, and is called the "crook." The first and second bars are tested for transverse strength and resistance to impact. The first test is made by a gradually applied weight, the deflection being measured at the same time. The resistance test is made by subjecting the bar to a series of blows from a 25lb. weight until it breaks, the fall being at first ½in., and increasing ⅛in. at a time. An arbitrary scale has been constructed, giving a value in pounds avoirdupois on an assumed value for a foot-pound. After these tests have been made the depth of chill is determined, and the grain of the fracture is observed by means of a pair of lenses. The hardness of the metal is finally tested by means of Turner's machine, in which a polished surface is set under a diamond of a standard cut, and the diamond is weighted until it produces a scratch similar to a standard scratch.—*Engineering.*

A RUN ON A GREAT NORTHERN ENGINE.

VERY uncertain ideas prevail amongst the public on this question of railway speed. Many people who travel a great deal take very little notice of anything but a book or a newspaper, while others are often heard to talk of "a mile a minute" without possessing very clear evidence for their statements. As a matter of fact, this very high speed is not attained by more than a few trains all over England, and certainly by very few in any one company's service.

Our whole railway system is a good specimen of all-round average velocity rather than occasionally remarkable speed. Thirteen trains, taken from as many different companies, show an average of 49·230769 miles per hour. Four companies, however—Great Northern, Great Western, Midland, and London and North-Western, average 52·5. The much abused "Southern lines"—Chatham, Brighton, and South-Eastern--attain 46·6, a speed which will, perhaps, surprise some of their most regular passengers; but it must be remembered that these figures are based upon the running of the best trains of each separate company, and of course excludes suburban traffic entirely. The famous Irish Mail itself, long associated with great speed in the popular idea, only averages 45·6 for its journey from London to Holyhead, and the fastest portion—viz., from Chester to Holyhead—is run at the rate of 48·12 miles per hour.

The fastest trains run are on the Great Northern Company's system. Five trains from King's Cross every day run the greater part of their journey at a speed considerably exceeding 50 miles per hour; and the 4-18 p.m. from Grantham to King's Cross—as every reader of "Whitaker" knows—is the fastest train in the world, running 105¼ miles in 1hr. 57min., or 54 per hour for the whole journey. By the courtesy of Mr. Stirling, locomotive engineer of the company, we had an opportunity recently of seeing for ourselves what his engines can do from the only place where such opportunities can be found—the foot-plate itself.

We travelled on engine No. 62 from London with the 2 p.m. Manchester express as far as Grantham, where the Manchester, Sheffield, and Lincolnshire engine takes the train in tow. From London to near Huntingdon the speed was well maintained against the long, but not unduly steep, gradients in the neighbourhood of Hatfield—1 in 200 for thirteen miles; and Hitchen, 1 in 200 for six miles. On the return journey some fast running was made. The train consisted of six ordinary passenger coaches—the usual load—with the addition of two saloons, containing the chairman and directors of the company. It left Grantham punctually at 4-18 p.m., drawn by engine No. 777—one of the pattern known amongst the drivers as "Jubilees"—with outside cylinders of 18in. diameter and 28in. stroke. The driving wheels, 8ft. 2in.; length of engine and tender, 50ft.; weight on driving wheels, 18 tons; trailers, 9 tons; and bogie, 15 tons. The driver was Thomas Lamb, of Grantham. Speed was soon got up after pulling up the bank at the foot of which the station is situated, and between Little Bytham and Essendine one mile was done in 46sec.; two others between Essendine and Tallington in 47sec. each. The first 24 miles occupied 22min. South of Abbott's Ripton another fast mile was run off—50secs.—and the full hour's work was 55 miles.

Both on the down and up journey the pressure gauge was generally steady at 140, and the coal consumption was about 22lb. per mile. From our own experience we can certify No. 777 as a very steady-running locomotive, not by any means such a "rough-rider" as the engines of some companies, with greater pretensions and less performances, certainly are.—*The Engineer.*

TOOL HANDLES.

AFTER the actual forms of tools themselves, the mode of their handling ranks as of chief importance. Habit counts for something; because, although there is adaptation between tool handles and their uses, there is yet much difference of detail in the modes of handling adopted. Even different men in the same shop will often have their own ideas as to these matters of detail. Again, a workman can often tell, even without looking, whether he is grasping his own tools or those of others; even though it would be difficult for a stranger to note any difference between them. It is, however, the broad distinctions between the types of tool handles which will be discussed in this article.

Grouping together the handles of the various chisels and gouges, we see that their forms are as variable as the purposes for which they are used. The heaviest chisels—those which are struck with the mallet—are the "socket" and "mortice," and these are short and stiff, and as strong as they can be made. Fig. 1 shows the mortice chisel. These are struck with the heaviest blows which the mallet is capable of imparting, and are driven into soft, stringy, hard, and harsh cross-grained woods alike. Then, in order to extricate them, they are wrenched out by force of leverage, in a direction parallel with the mortice, and the stiff proportions of the handles alone prevent them from becoming wrenched off from the tang. The ends of the handles also are well rounded, to delay, as long as possible, the spalting or splitting out of the wood. The shoulder of the mortice chisel is thick and stout, and so also is the socket of the other form. The handles are commonly made of ash, as being more tenacious and stringy than most woods.

The handles of firmer chisels are struck with the mallet also, but the tools themselves are much too slight to stand anything like the usage to which the first-named forms are subject; hence the handles are proportioned accordingly. They are preferably of the form in fig. 2, though often made of octagonal section. These will bear a moderate amount of malleting, and they can also be used as hand tools for paring.

The handles of the long paring chisels and gouges are not struck with the mallet, or at least not often. They are conveniently made of the form of fig. 2, and then the globular portion of the handle should be of rather large diameter, say 1¼in., to be grasped comfortably in the hand as a paring tool simply; the better the grip on this part, the more effective the downward pressure exerted, and the less the risk of slipping.

In the carvers' tools, which are held at all angles, the heel of the handle rests in the hollow of the hand, and the forms in fig. 3—A, B—are most suitable. These are used alike for the bent tools, and for the straight-nosed tools which are struck with the mallet. Often, except for the heaviest work, the hollow of the hand is the improvised mallet, its action being delicate and well under control. The handles are short, so that when grasped for cutting purposes the forefinger reaches nearly or quite down to the ferrule, so exerting pressure and control not very far from the cutting edge.

In a turning chisel or gouge the conditions are again different. No mallet is ever used; hence no shoulder is required at the termination of the tang, as is the case in all the other forms. But these turning tools are subject to sudden and excessive shock, demanding a corresponding power of control over them, which is provided for by giving excessive length to their handles (fig. 4), so that great leverage may be readily exercised. The grasp of both hands is necessary, in order to afford the essential power of control and guidance, where the position, angle, and mode of application vary at every successive instant. There are no angles or abrupt shoulders in these handles, but a good flowing, well-rounded outline admirably adapted for the grasp of the hands.

A bradawl handle (fig. 5) is always of a globular or nearly globular form, because it receives its thrust from the hollow of the hand, and an acutely rounded end would produce soreness. A file handle is similarly formed, though larger, and for the same reason. Handles of either of the previous types, if used for files, or for bradawls, would soon make the hands tender and blistered. Fig. 6 shows two file handles, A being well shaped, the broad well-rounded, almost globular end distributing the pressure over a large portion of the hand; B badly formed, because causing the pressure to be concentrated about one spot.

The handle of the screwdriver is admirably designed for its purpose, which is that of leverage and thrust combined. Fig. 7 shows the best form for such a handle. One too bulky would cause fatigue to the hand, yet considerable breadth is required for leverage; hence the breadth is increased and the thickness diminished, and all sharp edges rounded, by which means the maximum of power is obtained with the least fatigue to the hand. To prevent the twisting round of the tang in the handle, the shank of the screwdriver is flattened out and fitted into slots filed in the ferrule.

Fig 1

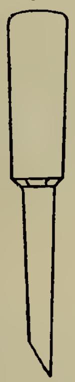


Fig 2

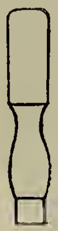


Fig 3

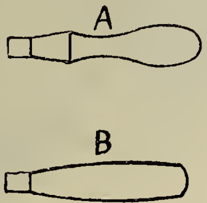


Fig 4

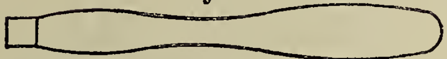


Fig 5

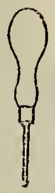


Fig 7

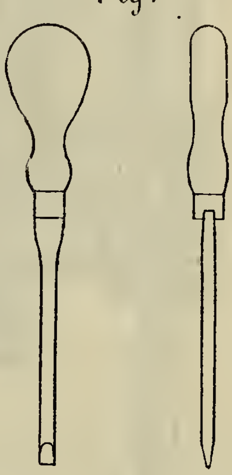


Fig 6

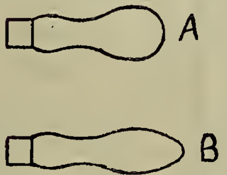


Fig 8

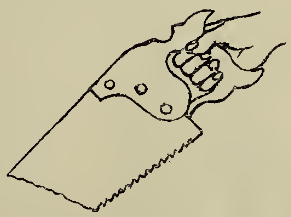
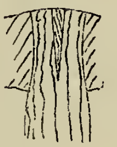


Fig 9



In the gimlets and augers the necessary leverage is provided for differently, by means of handles placed transversely to the shank, and increasing in length with the magnitude of the tool.

The hand saw and the tenon saw are tools whose handles are admirably adapted for their specific purpose. If we consider what is involved in the operation of sawing, the hand should be confined in the handle, while yet able to control its movement effectually. Varying pressure and guidance have to be exerted upon a saw, both in the plane in which it is cutting, and, laterally, either to turn it, or to prevent it from turning and running askew; hence the grasp of the hand has to be increased or relaxed, or its force applied more in one direction than another, and all the while retaining its hold without special effort. But for the confinement of the hand, by the bow form of the handle, it would slip, and sometimes lose its grasp, sliding off; as it is, the hand fills up and comfortaby grasps the handle, fig. 8, and directs its pressure, or its guidance, in the direction where it is most wanted. Not the least noticeable feature of the handle of a saw is the way in which it slopes backwards diagonally. In this way much or most of the downward force is applied, pressing down diagonally the teeth into the cut. The same peculiarity is observable in the handle of a plane, which is cranked, and leans forward in order to permit of the exercise of a sensible downward pressure. Some of the most primitive saws had their handles on the back, so that the thrusting force was directly normal to the line of cut. In the "cross-cut saw" the handling is quite different. Here the weight of the saw itself is quite sufficient to press it with ample force into the material; hence the handles stand quite vertically, and the only application of force necessary is that required to draw and thrust horizontally. In the large pit saw the handling is again different, two horizontal cross handles, one top and one bottom, providing the means of lifting, pulling down, and pressing forward into the cut. The small keyhole saw, for wood, has a handle much like that of a turning gouge in outline, though only of about half the length, and is thrust, pressed forward, and turned round in the cut. The hack saw, for metal, is similarly used, its handle is like that of a file, and the necessary pressure is imparted to the back of the frame. The handle of the bow saw is similar to the last.

The handles of axes, hatchets, and adzes are marked by several important characteristics. First, they are *oval* in section, then they are curved in their length. In each of these tools it is necessary not only to attack the timber in a vertical or horizontal direction, but also at various angles. The change in direction which it is necessary to impart rapidly to the axe or adze could not be given with such facility if the handles were circular in form, but, being oval, the hand effectually controls and guides their action by means of the leverage and firmness of grip afforded by that form, turning rapidly or preventing from turning as the case may be. Again, being curved lengthways, the hand is able to accommodate itself to the varying angular positions of the tool by permitting the handle to slide through it. The cranking of the handle in the adze also permits of the hand being brought close to the leg, while yet the cutting edge of the tool is at a safe distance from the toes.

The oval section is also given to the shafts of smiths' sledges, in order to obtain proper control over them when swinging. Engineers' hammers, and the hammers of metal and wood workers in general, have handles of oval section for the same reason. For these, handles of circular section would mean a loss of control.

The tendency of tools to fly off their handles by reason of centrifugal force is guarded against in several ways. Hammer heads are wedged on, with the wedges driven in from the outer end, and the eyes are opened out in that portion, so that the action of the wedge spreads out the cleft handle, filling up the enlarged portion of the eye (fig. 9). The adze head has a tapered eye, the larger area also being outwards, so that it becomes tightened by centrifugal force. Mallet heads are secured in the same way.

The tangs of chisels and gouges are invariably driven into the handles, holding there by virtue of their friction and the wedging of their taper outlines. Smiths' chisels or sets, in their various forms, are embraced by withy rods soaked in water, warmed, and twisted round; sometimes also by rods of iron. In each case the rigid wedging is dispensed with, in order to prevent the tingling jar of the hammer blow from being felt by to the hands. J. H.

WILBYS' PATENT STEAM REGULATOR.

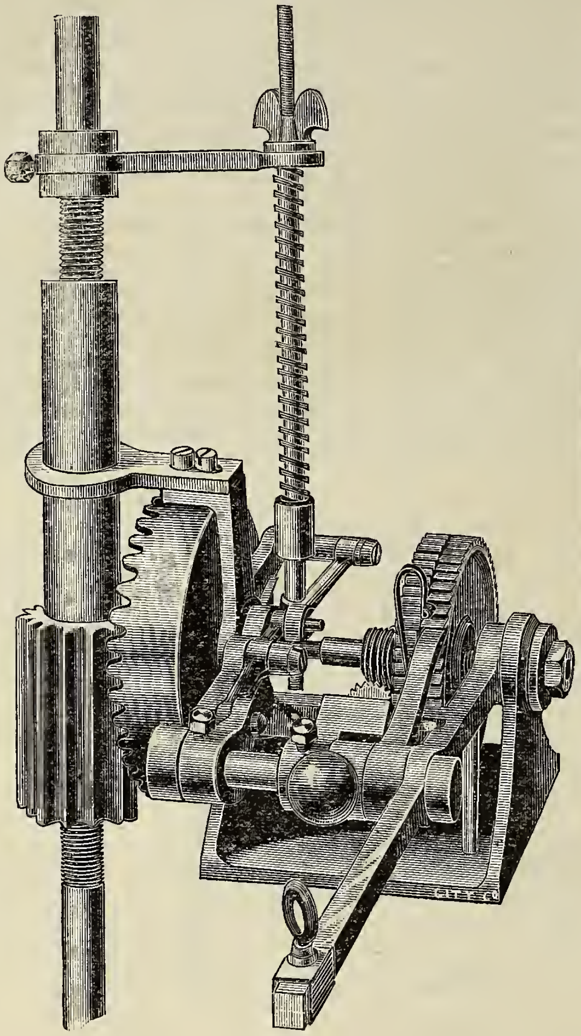


Fig. 1.

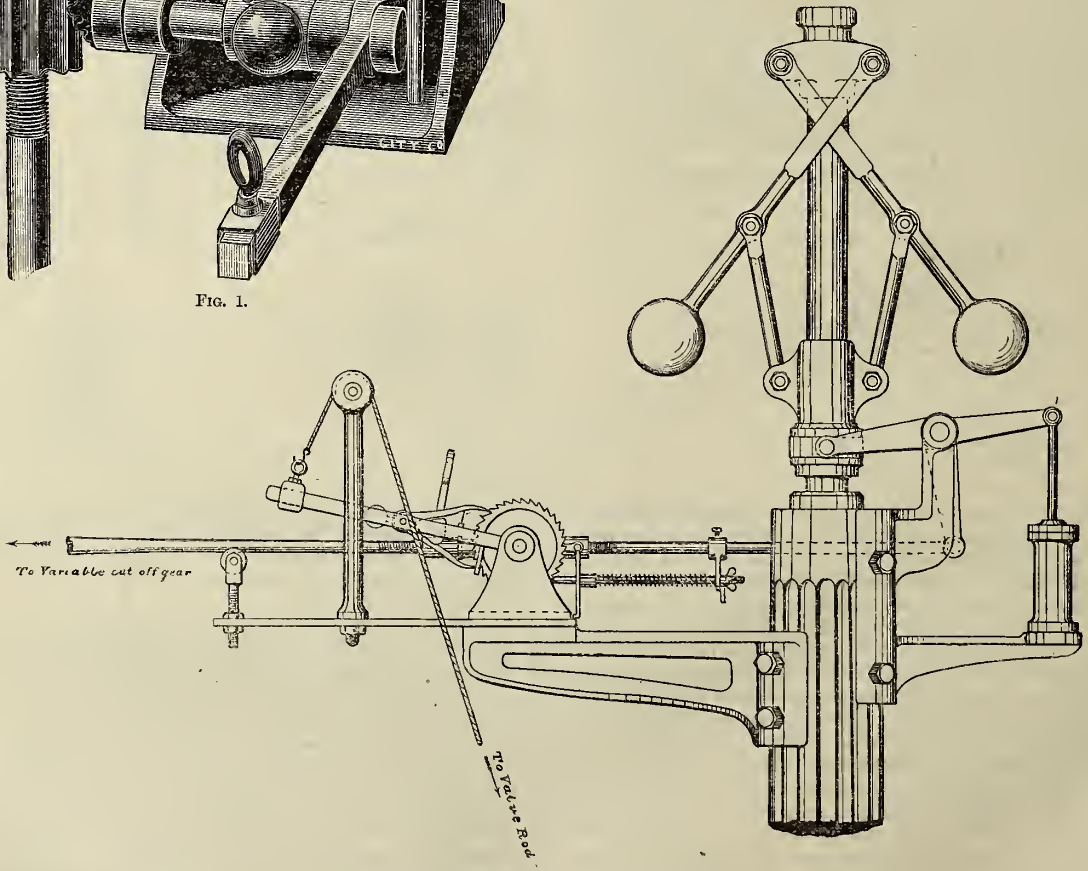


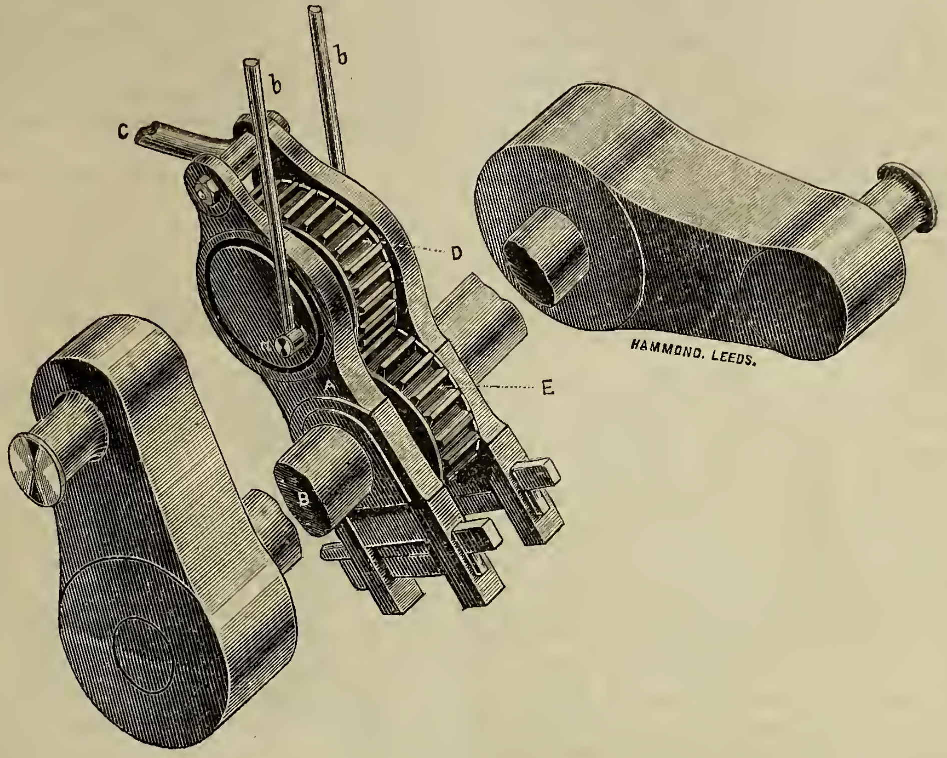
Fig. 2.

Of the various systems of contrivances for regulating the speed of the steam engine, in addition to the ordinary governor, about the most successful has been that which varies the length of the rod connecting the governor to the throttle valve in such a way that the governor itself may always revolve at the same level however wide the throttle valve may be opened, or, what is the same thing, however the load on the engine may vary. We have had the pleasure of seeing recently a contrivance of this character which has attained a marked degree of success, both on account of the ease and certainty with which it does its work and its cheapness, as well as the great facility offered by the machine for application to most engines. The machine is very small, as may be judged from the illustration (fig. 2), which shows its relative size as compared with an ordinary governor; in this case the apparatus has been arranged to open and close the cut-off plates as may be required. In fig. 1, which is another arrangement, the governor is supposed to act on the throttle valve through the vertical rod, seen at the left side of the illustration, and in this case all that is necessary when attaching the regulator is to cut the rod at a convenient place and to screw the two ends, the one with a left-handed thread and the other with a right-handed thread, to receive the nut of the regulator. When this nut is revolved in one direction, the rod is shortened, owing to the two ends being drawn together, and on the other hand, when the nut is revolved in the opposite direction, the rod is lengthened; and what the regulator does is to lengthen and shorten this rod according as less or more steam is required by the engine, thus compensating perfectly for variations of load and steam pressure without interfering with the ordinary functions of the governors. The manner of working will be understood from the following brief description.

The two ratchet wheels seen on the small horizontal shaft have their teeth facing in opposite directions, and engage respectively with two pawls pivoted on the same spindle, the one being above for the right wheel, and the other below for the left wheel. The latter pawl is kept in gear with the wheel by means of the round counter weight seen on the engraving. The frame carrying the pawls is swung loosely on the shaft carrying the ratchet wheels, and it receives an up and down motion by means of a cord tied to the eye bolt shown, and attached at the other end to any convenient reciprocating part of the engine, such as a valve rod. When the engine is running uniformly, neither of the pawls is in gear; but should any change take place, say a little of the load is thrown off, the slightest rise of the governors, caused by the increase of speed, immediately puts one or other of the pawls in gear, and the ratchet wheel commences to turn one, two, or as many

NEW VALVE GEAR.

DESIGNED BY MR. JAMES BEVERIDGE, OF BARROW-IN-FURNESS.



teeth as may be desired each stroke of the frame, which, through the crown wheel shown, revolves the nut on the rod, and so assists the governor in closing the valve. The movement continues so long as there is the least increment over the normal speed, and the valve is gradually closed. As soon, however, as the governor has got down to its normal level, the pawl is pushed out of gear again, and remains out until some other change of load occurs. For spinners, especially, this apparatus should prove invaluable, maintaining as it does a much more uniform rate of speed than could be possible with the unaided governor. We should say that there is a little attachment for preventing the nut being screwed too far in either direction, and so jamming the valve spindle, as might otherwise happen. The regulator is entirely self-acting, and we are told that where it is applied the engine may be run at a stroke more per minute, thus increasing the output of the machinery. The maker is Mr. James Lumb, Perseverence Brassworks, Elland, Yorkshire; and the Manchester agent, Mr. E. C. Mills, 49, Victoria Buildings.

NEW VALVE GEAR.

In the accompanying illustration we represent a peculiarly designed steam-engine valve gear, which may be described as consisting of a pair of wheels D and E gearing into each other; the last named E is a split one, and is keyed on the crank shaft, while the other D is fitted on a spindle, working loose between a couple of stout links A, or in a box frame enclosing the wheels. Each side of the spindle, to which the valve rods *bb* are coupled direct, has a pin A turned on. The rod C in our illustration is the reversing lever attached to one end of the links.

The gear works on the following principle: The proper amount of lead is given by appropriately setting the frame and the pins *aa* at the requisite angle to the cranks. To reverse the engine, the links are simply thrown over to the same angle as it makes with the vertical plane on the opposite side.

Mr. Beveridge claims the following advantages for this valve gear: (1) Absence of vibration at the main parts, combined with rigidity. (2) Difficulty of the valve working untrue, as this arrangement merely requires two joints, instead of the seven usually met with in eccentric and link motion gears. (3) Economy and durability of cost and wear. (4) Absence of complicated parts, ensuring an immediate and true action.

THE THERMO-DYNAMIC ANALYSIS OF THE GAS ENGINE.—II.

(Continued from page 165.)

So much, then, for the dynamic applicability of the three typical forms of the gas engine. Now let us turn for a while to the influence of water; I do not mean water jacketing, but water injection, or a mixture of steam with the charge. There have been many such; perhaps the one which came most prominently to public notice was the Simon gas engine, but I do not think it will be worth our while to spend time in discussing distinctive types of this class to any great extent, for we have only to take another look at my diagram of last year, where I show the comparative amount of work done by a given quantity of heat upon air and water respectively, and that proportion is about as six is to one. With that diagram before us, on which I have drawn a few fresh lines, it does not require a great exertion of the mind to perceive that whenever water is mixed with the charge of air and other dry gases, the combination resulting must be smaller in direct proportion to the quantity used. Thus, if we use a charge of dry gas only, we get a dynamic value of 2,920,784 foot pounds per pound of fuel; while if we use a charge of half dry gas and half steam, we get 2,920,784+506,385, divided by 2, equals 1,713,584·5 foot pounds per pound of fuel, or loss by the introduction of steam 1,207,199·5, about 40 per cent. This fact, I think, should at once put to one side all engines using an aqueous mixture as unworthy of notice, even in spite of the very glowing account which went the round of the engineering papers recently, when a new "thermo-motor" was said to work using only a little over half a pound of coal per H.P. per hour.

It is quite surprising to see the number of patents which have been applied for, having as the principal feature of improvement an aqueous mixture in one form or another.

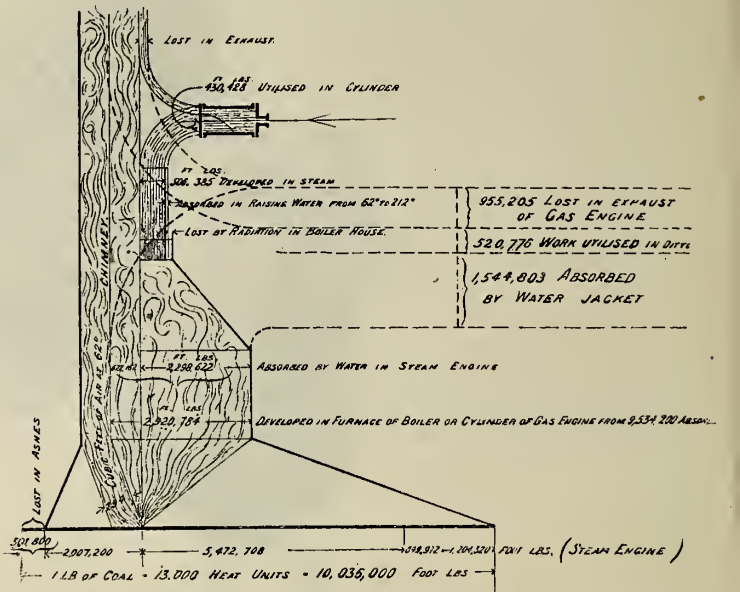
But there is another form of the application of water to the gas engine which is such an important factor in the success of the gas engine as we are most familiar with it at the present day, which we cannot so easily dispose of, though an acknowledged great evil. I need hardly say I refer to water jacketing, and here it will be interesting to refer to Clerk's admirable little work on the "Gas Engine," page 176, where a dynamic analysis is given of an Otto engine.

Clerk here improves upon his original paper read before the Institute of Civil Engineers, 4th April, 1882, where he put the latter two items into one, but he is still one item short, namely, the amount lost by incomplete combustion, an item of no mean importance. The difficulty of getting at accurate figures from practice is exceedingly great, and I am afraid experimentors have been too apt to presume that after getting at certain items which they have been able to ascertain pretty closely and with a fair degree of certainty, that what remains unaccounted for must be the item they cannot measure. And this brings us to that much vexed question of dissociation. Of all the experiments that have been made on this subject I do not think there is one reliable, or even near enough to mention an approximate figure with any degree of certainty. The very nature of the experiment, as we have been accustomed to see it carried out, puts it beyond the possibility of correct investigation. I do not think we can ever get at the point of dissociation by experimenting in closed vessels, for the simple reason that I am convinced it is entirely regulated by pressure, and on a diagram would form a curve of inverse ratios somewhat similar to the adiabatic, but far above it. It is a matter of great surprise to me that the influence of pressure upon the point of dissociation has not been more fully recognised.

On the occasion of the great discussion on Clerk's paper, before referred to, although such men as Sir William Thomson, Professors James Thomson, Jack, and Ferguson, and others, it was entirely ignored, and even up to the present day I have no evidence that any serious note has been taken of it. To illustrate what I mean, let us look for a moment at the boiling point of water. It is all very well to say that water boils at 212 deg. Fahrenheit, but put it under a pressure of only ⅛th of an atmosphere, and it will boil at a temperature of about 100 deg. Fahrenheit, or that of a comfortably warm bath; or, on the other hand, increase the pressure to 10 atmospheres, and you will not be able to boil it at a lower temperature than 357 deg. Fahrenheit. If, then, pressure regulates the temperature of dissociation of water, as water, and at certain pressures and temperatures prevents the molecules from flying off from one another, have we not every reason for supposing that a similar condition of things obtains at the higher temperatures, regulating the temperature at which the molecules themselves split up into their elementary atoms? If this is so, then experiments in closed vessels are perfectly useless, for the pressure produced by ignition entirely counteracts the dissociation tendency. In support of what I say I may quote Capt. Andrew Noble, who says: "Little or nothing is known of the extent to which dissociation takes place at the very high temperature produced by the gases we are discussing. That extent, whatever it may be, will doubtless be largely reduced as the tension at which the explosion is carried on is increased."* A little further on he states: "Calculation places the temperature of explosion of ordinary English gunpowder at a little above 2,000 per cent., and the direct experiments I have been able to make confirm this estimate." "The temperature of explosion of guncotton is at least double that of gunpowder, and all the internal apparatus we have used bears notable signs of the extraordinarily high heat to which they have been exposed."† "Sir F. Abel and I, although it is dangerous to be too dogmatic with respect to reactions occurring under conditions so enormously beyond the range, both as regards temperature and pressure of ordinary experience, are inclined to think that both with regard to guncotton and gunpowder the effects of dissociation, if they exist at all, are practically inappreciable. At all events, the actual pressures as measured, both in case of guncotton and gunpowder, are certainly not below those required by theory."‡ I may mention here that the pressures realised in the experiments Capt. Noble referred to reach as much as 70 tons to the square inch for guncotton, and 43 tons to the square inch for gunpowder. Leaving these enormous pressures, and coming down to the ordinary atmospheric pressure, let us first take a glance at the steel-melting furnace. We know that some steel does not melt much under 2,600 deg. Fahrenheit, and we know that steel melting would be carried on at a very slow pace if the temperature of the furnace is not several hundred degrees higher; such a furnace, then, must be from 2,800 deg. to 3,000 deg. Fahrenheit, and there seems to be no approach to dissociation in these furnaces. If, then, there is no dissociation at 2,800 deg. Fahrenheit and 15lb. pressure, how much less should we expect to find dissociation at 220lb.? It seems to me beyond all possibility for dissociation to come within any temperatures and pressures ever likely to be used in a gas engine, and I am very much inclined to put the theme entirely to one side as unworthy of further argument, and account for checked inflammation in another way.

In a paper read by Clerk before the Society of Chemical Industry, January 29th, 1886, he gave the results of some experiments which I will reproduce. I am sorry he is not here to give us the benefit of a personal explanation. It is evident he has given up the dissociation theory as affecting the gas engine. What, then, is the cause of this slow combustion? Can we set up any theory that will account for it? Let us try by making one or two diagrams of the different stages in the progress of combustion.

The comparative Analysis of the Gas Engine is shewn by the dotted lines


Lost in Exhaust.
Ft. Lbs.
430,428 Utilised in Cylinder
Ft. Lbs.
506,335 Developed in steam
Absorbed in Raising Water from 62° to 212°
Lost by Radiation in Boiler House.
955,205 Lost in exhaust of Gas Engine
520,776 Work utilised in ditto
1,544,803 Absorbed by Water Jacket
Chimney
Cubic Feet of Air at 62°
Ft. Lbs.
2,298,622
Absorbed by Water in Steam Engine
Ft. Lbs.
2,920,784
Developed in Furnace of Boiler or Cylinder of Gas Engine from 9,534,200 Absor
Lost in Ashes
501,800
2,007,200
5,472,708
1,204,320
Foot Lbs. (Steam Engine)
1 Lb of Coal = 13,000 Heat Units = 10,036,000 Foot Lbs

We know the composition of air is four volumes of nitrogen and one of oxygen; this may fairly be represented by the first term of the diagram. Common coal gas in round figures is composed of four parts of hydrogen and one of carbon; this we may represent by the second term. In the Otto gas engine a common working proportion is one of gas to about twelve of air. The diagram now, I think, speaks for itself; the small light letters represent the air both in quantity and dispersion of the atoms, and the larger and thicker letters represent the gas in combination with the oxygen of the air. This diagram seems to me, though I do not profess to be a physicist of any great authority, to demonstrate that combustion is by no means a simple or single operation. We can suppose the hydrogen, which has a very great affinity for oxygen, completely combined in a very short space of time, for it is easily satisfied, a couple of atoms of the hydrogen only requiring one atom of oxygen. Not so, however, with the carbon; it is four times as greedy of oxygen as hydrogen, and may be involved in a double operation: first, that of taking up one atom of oxygen to form carbonic oxide, having done which, it has to seek about, as it were, to find a second atom to form carbonic acid and complete combustion. Now, this seeking about must take time, and that time must vary with the amount of commotion going on at the moment. The greater the commotion the more rapid the combustion. In the gas engine of the day the commotion is comparatively small. The charge is first closed up within the cylinder, commotion comparatively easing. Then, by the firing, it is violently but only momentarily agitated, and expansion begins; but expansion is not commotion. It is only a widening apart of the atoms or molecules, their relative positions not necessarily changing. There would be a slight commotion certainly, this slight commotion slowly causing the propagation of inflammation. Agitation after ignition seems to me a very important element in the future gas engine.

To be continued.

The Nile.—A telegram from Alexandria states that Colonel Moncrieff reports favourably on the Whitehouse project, and considers Wady Raian convertible into a great reservoir with a surface of 256 square miles, capable of augmenting the Nile volume by 20 million cubic metres daily during the hundred days of low Nile. He estimates the cost at £827,000, and considers the realisation of the scheme would be a distinct benefit to Egypt.

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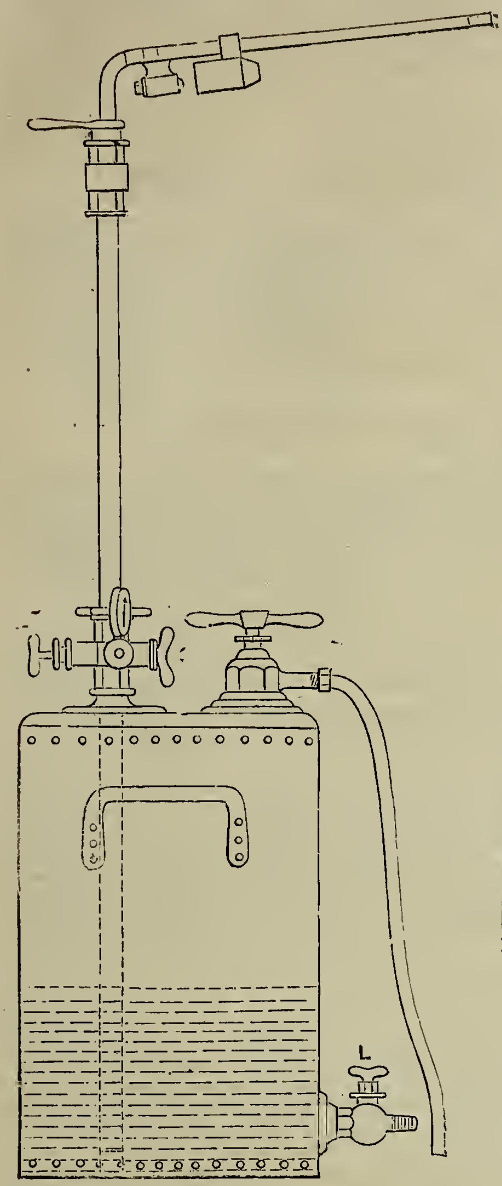
* Proceedings of Instituto of Civil Engineers, 3rd April, 1884, pages 14 and 15.
† Proceedings of Institute of Civil Engineers, 3rd April, 1884, page 19.
‡ Proceedings of Institute of Civil Engineers, 3rd April, 1884, page 23.

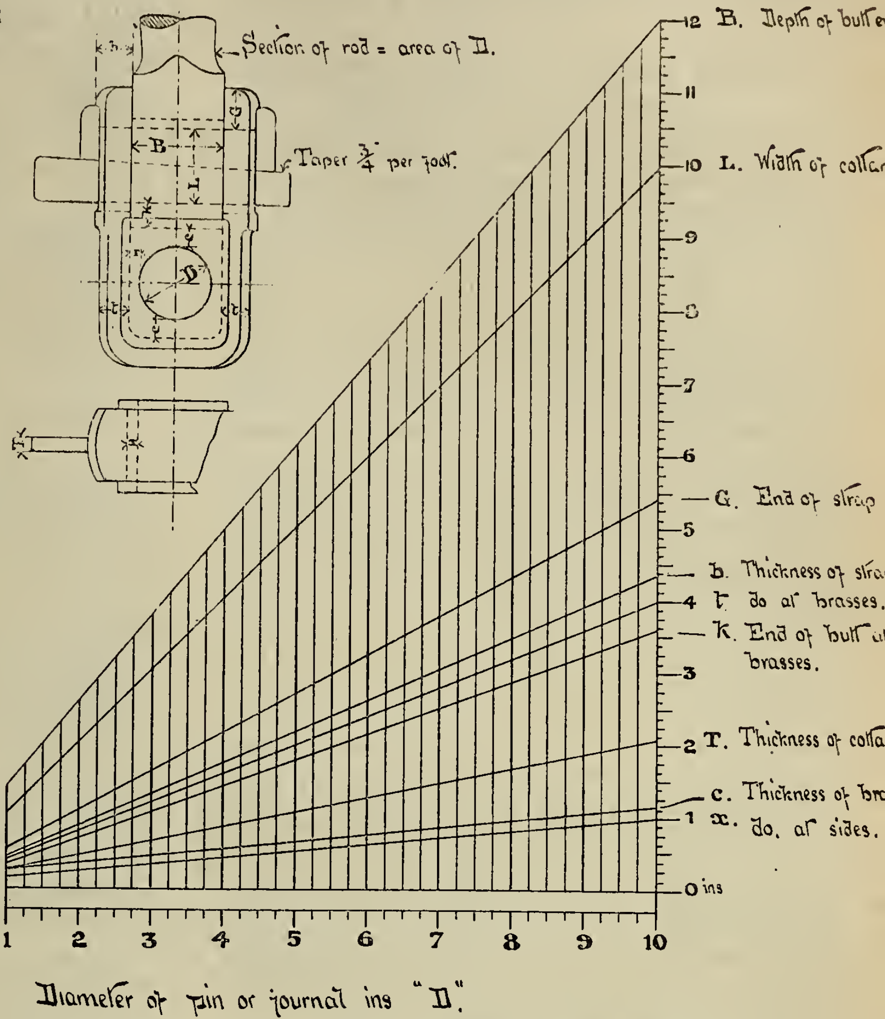
THE WELLS LIGHT.



We give herewith an illustration of the Wells light, the subject of various patents, the property of Messrs. Wallwork and Wells. The lamp is being put on the market by Messrs. A. C. Wells and Co., of Ardwick, Manchester, who have a well-known name for their small unbreakable lamps and oil feeders. This lamp is now made in a very simple form, and the large quantity sold and the testimonials received prove that the public consider it a commercial success. As will be seen, the lamp is entirely portable, requiring no engine, boiler, or air-compressor to drive it, and therefore no skilled attendant is needed. The light can be put to work in a few minutes, and can be carried about easily by two men. The actual working cost of a light of 2,000 to 2,500 candles, which is the size of burner the makers generally supply, is 2½d. to 3d. per hour. A special, cheap oil, which gives the best results, as supplied by the makers. The lamp is suitable for indoor work, such as lighting foundries, engineering works, &c., and for all classes of outdoor work it seems invaluable. The only attention required is the application of the small hand pump affixed every few hours for a couple of minutes.

Architects' Registration Bill.—At a meeting of the Council of the Manchester Association of Engineers, held on Tuesday at the Grand Hotel, it was unanimously resolved that the proposed registration of engineers, as contemplated by the Architects' Registration Bill, now before Parliament, would be highly injurious to the best interests of engineering and mechanical science.

PROPORTIONS OF GIB AND COTTAR JOINTS.



LOCOMOTIVE BOILERS.

At a recent meeting of the Finsbury Technical College Old Students' Association, a paper on "Locomotive Boilers" was read by Mr. Follett Holt, Stud. Inst. C.E., and was illustrated by a large number of diagrams. After comparing the results obtained from the locomotive type with those obtained from other forms of boilers, the author gave a number of tables showing its evaporative efficiency under various circumstances. He then proceeded to trace its development from the primitive form devised by Timothy Hackworth, in 1818, and showed how, by the general adoption of improved processes of manufacture it had gradually been brought to its present state of perfection. By the substitution of steel for iron in the shell he estimated that a saving of over £50 per boiler was effected, simultaneously with an increase in its strength and durability. He further showed the desirability that the experiments with steel fire-boxes made by the English locomotive superintendents should be continued and brought to a successful issue, as thereby, at the present price of copper, a saving of £120 per engine would be effected by the use of steel. After sketching the distinctive features of the boilers used on the locomotives of the various English, continental, and American railways, the author gave an interesting and graphic account of the methods adopted at the London and South-Western Railway Works in the construction of one of their standard boilers, describing the general features of the tools used in the course of its manufacture. Amongst them was an ingenious machine for the hydraulic testing of the boiler tubes by means of water at the pressure of the ordinary mains, invented and patented by the author, in conjunction with Mr. Bodley.

The Great Eastern.—The "fate" of the famous steamship Great Eastern appears to be sealed. Tenders are being asked for "taking out the paddle-engines, shafting, paddle-wheels, paddle-boxes, and sponsons." The huge vessel is lying near Greenock.

CORRESPONDENCE.

We do not hold ourselves responsible for the opinions of our Correspondents.

TALLOW CUPS v. SIGHT-FEED LUBRICATORS.

To the Editor of "The Practical Engineer."

SIR,—In your issue of last week "Economy with Efficiency" has made some rather strong and misleading remarks on my letters of the 2nd and 23rd ult.: in the first place misleading as to boiler pressure, asserting as a positive fact, not a probable one, that my boiler pressure is low. This is not the case, but it is most likely as high as his. Now, the question of boiler pressure has not been mentioned before, neither by "Eureka," "Artizo," nor myself. I might ask how does he know the condition of the pistons he speaks about if he does not examine them, also what order were they in when they stopped suddenly with a groan—proving by his own statement that automatic lubrication is more economical than the tallow-cup system, which I understand to be the real question at issue. I have engines which have been at work for thirty-six years, and, as I stated in my letter of the 2nd of March, lubricated with the sight-feed this last four years, and cylinders and valves and valve faces are like glass. In the next place, I consider his remarks rather strong when he says, as to the other reasons, "I count them as nothing." Now, the other reasons I gave were that the sight-feed system was more economical than the tallow-cup system, and I think every man is entitled to a wholesome respect for his own opinions; and what I stated was not only my opinion, but my practical experience of the two systems of lubricating; and if I understand his letter right, he also has found it to be the best system, for he says: "I have it from each engineman that it does not take near so much steam to drive the engines as it did previously." I should have thought the fireman would have been able to settle that question best; and as for the engines making three or four revolutions after steam is shut off, I should think mine were very much at fault if they did not make a dozen, notwithstanding that the shafting passes through upwards of 630 pedestals. But, I suppose, this experience will count as nothing in his opinion. Then he says he expected to see, and was not disappointed, a reply to "Eureka," stating how much oil and fuel I had saved. Now, on the contrary, "Eureka" did not ask any such question about saving of oil and fuel, but simply the number of lubricators, the kind and price of lubricant; and these questions I answered by telling him the truth, and I say again it is misleading to say that I advised "Eureka" to purchase the most expensive lubricators and oil, as I did no such thing. But I am of opinion that the eighteen lubricators "Economy with Efficiency" has fixed to his cylinders will have cost almost as much as the sight-feed. As I am placed in the same position as him in having to supply steam for other purposes, I cannot give the exact saving in fuel, but in oil it is considerable. I hope that this correspondence will be carried on with good feeling, and with the intention of helping one another to the best information and practice.—Yours, &c.,

April 7th, 1888. SIGHT-FEED.

To the Editor of "The Practical Engineer."

SIR,—I have been much interested by the correspondence which has appeared in your columns on the above subject. Having, like your correspondent, "Economy with Efficiency," made this matter a special study, I trust my experience may be acceptable to your readers.

I cannot help expressing my surprise that there are men to be found who still profess to doubt the advantages of the sight-feed lubricator. These advantages seem to me to be so self-evident as to be quite beyond question. In the first place, the supply of oil is uniform and constant. If anyone has found a difficulty in arriving at so desirable a result, it is because he has not got the right sort of lubricator or oil, or else the lubricator is not properly fixed. Then, it is possible to adjust the quantity of oil to so great a nicety that you can ascertain exactly the number of drops your engine requires, and always set the supply accordingly. This is impossible with any other form of lubricator. Pumps, ratchet cups, and others designed to give a constant feed cannot be relied on, because the supply of oil is liable to fail at any moment, and, unless they are specially fitted up with a glass tube, this may remain unnoticed until the next filling time, or until the engine itself lets the attendant know, as it sometimes does with disastrous results. But with a good sight-feed lubricator there is no danger of galling for want of oil, and no possibility of waste by feeding too rapidly, which I regard as the highest form of economy with efficiency. Not the least point in its favour is that the sight-feed cup has no moving parts, and consequently is not liable to get out of repair; while for cleanliness no other cup can compare with it.

I have worked almost every form of lubricator, and used most of the leading kinds of lubricants, and the conclusion I have arrived at is that, for comfort and reliability in working, the sight-feed cups of Messrs. Boult Bros., Liverpool, are unsurpassed; while for purity, durability, and uniform quality, the Valvoline oil, obtained from the same firm, is unequalled. But you want to be sure you get it genuine; for I have found (to my sorrow and my employer's cost) that many oil dealers try to imitate it in appearance and in name. I do not share the feeling of some of your correspondents, that a good thing should be kept to oneself, or only communicated in secret. Being in the centre of a manufacturing district, I have recommended this system to a number of my fellow-engineers, whose experience has in every case been like my own. I will just give a few figures taken from my notebook, showing the economy of the sight-feed system compared with the old style. In a concern under my charge, with three pairs of engines, indicating 1,800 horse power, we used, with tallow cups, in three months, 3,475lb. of best Russian tallow. I got a sight-feed cup on one pair of engines, and in the corresponding three months of the following year our consumption had fallen to 2,698lb. of tallow and oil, a reduction of more than one-fourth. I then put a sight-feeder on each of the other two pairs of engines, with the result that at the present time 1,080lb. of Valvoline oil lasts the same length of time. The packing, being kept soft, lasts longer, and does not score the rods; and whereas the valve rods were being constantly eaten away, and piston screws destroyed by the acid which all tallow and many oils contain, they now look like new every time they are examined. So convinced am I of the superiority of this system over any other, that I will gladly answer any inquiries which may, with your consent, reach me through your office (enclosing stamped addressed envelope).—Hoping in this way to help some who are yet in doubt or difficulty, I remain, sir, CORLISS VALVE.

BOILER REGISTRY AND INSPECTION BILL.

To the Editor of "The Practical Engineer."

SIR,—The above bill still lives, but is not yet law, and the question as to its advisability in its present, or even in an amended form, is yet far from being settled by practical men. I think any unbiased, reasonable, practical man will admit that a law compelling all enginemen and firemen to hold certificates of competency would not be conducive to the general good of the public or to enginemen in particular. Let us just think what form such a certificate must take. Are there to be different grades of certificates? Such have not yet been suggested; therefore we will assume that there is one examination only. Who shall arrange that examination? Board of Trade, of course. Suppose the examination is but an elementary one; what is the result? The highly gratified and widely recognised engineer is on the same legal level as the boy of fifteen who has attended a science class one session and spent his leisure hours in his father's works. The practical engineer is on a level with the stoker, and the stoker is legally qualified to replace the engineer, and the responsibility of the owner in case of breakdown or explosion is still on someone else's shoulders. Let us, again, suppose the standard of merit or examination is somewhat advanced, say, equal to that required to gain a second-class certificate for a marine engineer. How many of our ordinary engineers of to-day would be able to pass it, and what would those think of themselves who fortunately did pass it? Still it must be passed if you are to have charge, and if such becomes law, how is the best man going to fare alongside his inferior brother? The employer will fix the value on the certificate, not on the man. A man who can pass such an examination, and at the same time has a fair practical knowledge, is generally found in a fair berth, seldom under 45s. per week, and if this must be the standard, thousands of those who now have steam coffee mills, chaff cutters, cranes, small pumps, laundries, &c., must at once close their works, as 45s. per week paid to a boiler attendant would mean more than the total profits. Still the certified man is worth the amount, and has a right to claim it, or refuse to work; therefore either the certified man must be engaged, or the work allowed to stand. Let this state of things come about whenever it may, and that great dread of employers generally will be realised in its worst form, while many of our good, honest, practical men (though he may come from a "brickyard," as one of your writers sneeringly said in a most uncharitable and hostile letter) will have to stand aside for those less practical, often unsteady, and frequently more skilled in malice. I fear the advocates for this so-called boon will have a hard task before they can show that ignorance is accountable, to any appreciable extent, for the lamentable explosions which now occur, a few statistics of which I recently gave. As I have previously said, I believe there are good times coming for practical men, but an attempt to hurry them will much delay them. Even at present we generally find good men get in good situations, and the grumbling we now hear is often from those who think they know what they do not know, and to many such a certificate of competency would be a boon indeed.—Yours, &c.,

CHALKLINE.

SMOKE CONSUMERS.

To the Editor of "The Practical Engineer."

SIR,—Having read the letter by "Boiler Inspector," in which he advocates a public test of the various smoke-consuming furnaces or machines, so that steam users and engineers may have a guide as to the method best calculated to secure the greatest economy in working practice, and at the same time attain such efficiency in preventing the smoke nuisance as will satisfy the sanitary powers, it has struck me that in the absence of a guide such as the result of a public test would be, it would be interesting to many of your readers to know that the assisted draught furnace and smoke consumer which "Boiler Inspector" refers to appears to give satisfaction to the medical officer of Oldham. The *Oldham Express*, of March 10th, 1888, states that at a meeting of the Sanitary Committee "the Medical Officer of Health (Dr. Niven) reported that he had visited the Oldham Boilerworks, and had examined the apparatus there in use for the consumption of smoke. His impression was that it was a good thing, and would effect the object for which it was needed."

If it gives satisfaction to the sanitary powers of Oldham, it seems likely that it should also satisfy any other sanitary powers, for there is no place where the smoke nuisance is so flagrant or reform more needed than in Oldham.—Yours truly,

Oldham, April 10th. ENGINEER.

QUERIES AND REPLIES.

ELECTRIC BATTERIES.—(1) Would any one alone of the following cells—Danniell's, Leclanché, or bichromate—be strong enough to decompose acidulated water? If not, how many would be needed in series? (2) How many of either kind—Danniell's, Leclanché, or bichromate—would be needed to light and maintain a small glow lamp, say of 6 c.p., and how should they be arranged? and (3) would a Danniell's cell work connected to a bichromate or a Leclanché celll, or *vice versa*?—VOLT.

Answer.—(1) No; two would decompose water in series. (2) My 3 c.p. lamp takes three bichromate, so your 6 c.p. would most likely require six bichromates in series; or perhaps seven Danniell's would do it. Leclanché's are never used for lighting. (3) Yes, you could connect them together, but it would not be wise to connect bichromates or Danniell's up with Leclanché's, on account of the great internal resistance of the Leclanché.—T. H.

MARINE ENGINES.—Will some engineer kindly give me his opinion on the following matter? Assuming a compound marine engine, with cylinders of 46in. and 88in. by 4ft. 9in. stroke, 64 revolutions, boiler pressure 108lb., cut-off in h.p. cylinder at ⅓ stroke, developing 3,300 i.h.p. on a coal consumption of 1·78lb. and 15lb. per square foot of grate, what would probably be the coal consumed and boiler pressure maintained to give similar power if the large cylinder only were worked?—ANTIPODES.

Answer.—Probable coal consumed 2·5lb. per h.p.; cut-off at ⅓; mean pressure 29·3; boiler pressure 35lb.—E.

BRIGHT WORK.—What is the best thing to put on bright work, after polishing, to keep coke oven sulphur off? I use tallow, but it gets through that the next day.—ENGINE.

Answer.—Take paraffin oil and beeswax, and mix to form a jelly; apply the same as tallow.—S.

Answer.—Cosmoline and anti-corrosive varnish are both good substances for covering bright work. The manufacturers are W. H. Palfreyman and Co., 87, Piccadilly, Manchester.—H.

SPLICING ROPES.—Will any reader kindly inform me what are the most modern methods of splicing ropes for working on pulleys, and do those methods labour under any disadvantages?—R. L. F.

DRAG LINKS OF PADDLE ENGINES.—A dimension sketch and description would be of value to the undersigned; also please say whether the link should not lie freely on the pins, like the coupling rod of a locomotive, instead of having brasses so tightened up as to make it immovable, and oblige—SHINY BOOTS.

STAMPING MACHINE.—Can any reader inform me where the best machines are to be procured for general tinplate workers' stamping, or, as the French call it, embouté, all kinds of tin articles?—J. H.

COLLIERY ENGINES.—(1) A colliery has an output of 1,000 tons of coal, raised from a depth of 120 fathoms in 10 hours. Give h.p. of engines, diameter of cylinders, diameter of drums, pulleys, steel wire rope, number and size and h.p. of boilers, to do the work. (2) There are 800 gallons of water per minute in the above pit. Give h.p. of engine, diameter of cylinders, diameter of pumps, length of stroke, size of pump rods, number and size and h.p. of boilers, allowing boiler pressure 40lb. per square inch in both questions, the pumps to do the work in 10 hours per day.—J. W.

TWINER SPINDLES.—How many twiner mule spindles are reckoned to the horse power?—INQUIRER.

ILLUMINATING PAINT.—I should be glad to have the address of a maker of illuminating paint.—S. C.

ELECTRO-PLATING.—Could any reader kindly inform me how I best could re-electro.plate a tricycle? The cheapest and simplest style will oblige.—CLUB TANDEM.

TWIST DRILLS.—Can any reader give me any information regarding these? Are they milled? If so, how? Is cutter arranged to get the under-cut? How are they ground for clearance? Could they be cut in a lathe?—A. R.

DESIGNING ENGINE CYLINDER.—I intend making a steam engine, 3in. bore, 6in. stroke. Would some one kindly show me how to find the size of posts, and thickness of material, cylinder and steam chest (ordinary cast iron); also length of connecting rod?—BOLT.

STEEL PLATES.—Will some reader kindly give me a list of lengths and widths of iron and steel plates kept in stock by most merchants. What I want is to be able to design tanks, boilers, &c., without having to get them cut, as this increases the labour, and does not add anything to the strength.—H.L.C.

REGULATING ENGINES.—Will some of your readers kindly give me their experience as to the best arrangement for regulating an engine with constantly varying and extreme loads; *i.e.*, whether to apply sensitive governor to throttle or to variable cut-off gear. The particular engine I have in view has slide valve with cut-off plates on back, and boiler pressure of 70lb.—X.Y.Z.

TO CORRESPONDENTS.

A BEGINNER.—The exact point of cut-off cannot always be determined from the diagram on account of the wire-drawing effect of the slowly-closing valve, which gradually merges the steam line into the expansion line. Usually the steam line has its concavity downwards, while the expansion line has its convex side downwards, and the place where the change occurs may be assumed without much error as the point of actual cut-off.

E. P., Stalybridge.—Porter's book on the Indicator is about the best of its kind. Its price, we believe, is 7s. 6d. If you want other information as well on the steam engine, then a work like Holmes's will suit you best.

SCREW.—Pearson and Knowles Coal and Iron Company, Limited, Dallam and Bewsey Forges, Warrington.

A. E. T.—We do not know that there is any such book published. There is a little book on Cranes in Weale's series, price 1s. 6d., but it does not contain working drawings.

APPRENTICE.—The diameter of air pump should be 16in. if the stroke be 10in. and revolutions 120. A safe rule to adopt is to make the air pump one-eighth the size of low-pressure cylinder, if it is driven at the same speed.

ANXIOUS.—See the Pulsometer advertisement in this journal.

COMPOUND ENGINE.—The pressure must be taken from the diagrams by measuring from the steam line of the diagram from one end of the cylinder to the back pressure line of the diagram from the other end. This applies to both cylinders alike.

W. PICKARD, Oldham.—Will you please forward your address to this office?

T. G. W.—Theoretically, the correct and most economical way to govern is by altering the cut-off, but, in a small engine especially, we doubt if there is any saving as compared with a good governor operating on the throttle valve. There are many excellent governors for horizontal engines in the market, but we cannot pretend to decide as to which is absolutely the best.

FITTER.—The energy in a moving body is equal to $\frac{w v^2}{2 g}$ where w = weight, v = velocity in feet per second, and $g = 32$; so that first find the velocity of the rim of the flywheel in feet per second, square it, multiply by 500, and divide by 64. This gives approximately 1700 foot lbs. The work done by the engine per revolution is simply $\frac{4 \times 33000}{75} = 1760$ foot lbs., so that the work done per revolution is slightly in excess of the energy stored up in the flywheel. To find the variation in speed it is simply necessary to remember that the velocity varies as the square root of the energy put into or taken out of the wheel. If the total variation of energy is 25°/o, or 12½°/o above and 12½°/o below the normal, we have the highest speed $= \frac{3}{\sqrt{8}} \times 75 = 80$ approximately, and the lowest speed $= \frac{\sqrt{8}}{\sqrt{7}} \times 75 = 70\frac{1}{2}$ approximately. The above figures are not worked out accurately, but will show the method of procedure.

A.M.—Communication crowded out.

T. G. W.—Spelter or hard solder is made from equal parts of copper and zinc. The alloy is again heated over a charcoal fire and broken in a mortar. The flux is borax. When the work is cleaned, bound, fluxed, and speltered, it is subjected to a charcoal or blow-pipe flame, and when the solder fuses and flushes the work it is withdrawn, allowed to set, and then cooled in water.

AN OLD READER.—You would have done better to have asked what part of the wheel was in dispute. If it is the formation of the teeth, we may say that the best and most usual method is to dovetail blocks into the boss or the rim of the wheel, which, after turning and marking out, may be knocked out and worked to shape with the plane instead of with the chisel, as is necessary when the blocks are glued on the periphery. The method is expensive, but is the best where great accuracy is desirable.

MISCELLANEA.

DERAILMENTS.—The *Engineering News*, America, records nineteen instances in which locomotives were derailed in the late storm, by being butted into snow banks, with more or less wreckage.

RAILWAY EXTENSION.—A new railway, which has been about two years under construction, between Barking and Pitsea, on the London, Tilbury, and Southend Railway, will be opened next month.

LARGE DECREE FOR VIOLATION OF A PATENT.—The Supreme Court of the United States has just awarded R. A. Tilghman, of Philadelphia, $320,000 damages for the infringement of his glycerine patent.

PROPOSED SHIP CANAL.—There is reason to believe that during the coming spring the initial step will be taken to ascertain the possibility of constructing a ship canal, or one for vessels of burden for about 500 tons, from Sheffield to the Trent.

SLIPPING BELTS.—To prevent a belt slipping it is not necessary to use oil. If a belt slips, take a piece of soda and hold it on the inside of the belt, and it will make the belt cling fully as well as any oil will. It makes a nice smooth surface, and does not injure the leather.

INDIAN TRAMWAY.—According to a Deccan paper, the application to construct a tramway from Hyderabad to Secunderabad has been sanctioned on condition that certain streets in the cantonment are widened. If this is possible, the work (says the *Indian Engineer*) will be taken in hand at once.

DRILLING EARTHENWARE.—According to Professor Stuart, earthenware may be perforated by using, instead of a drill, a soft copper rod or pipe fed with a mixture of emery powder and linseed oil. The emery is embedded in the copper by the friction, and cuts through the hardest material in a very short time.

The Danube.—The regulation of the rapids and cataracts on the lower Danube, known under the collective name of the "Iron Gate," will, it is thought, cost much more than 9,000,000fl. It is pointed out that, owing to the changes in the state of the Danube, the works, which in any case will occupy a period of about ten years, may often be interrupted for months.

Torpedo Engine Tests.—The Fearless, torpedo cruiser, has returned to Portsmouth after three ineffectual attemps to complete a 96 hours' continuous full-power run of her engines, previous to being commissioned for the Mediterranean. The first two attempts were frustrated by stormy weather, and the last was brought to a premature end by the excessive leaking of her boiler tubes.

Forest Depletion.—When we learn that some 35,000 saw mills are in operation in the United States, we can well imagine the rate of forest destruction. The value of the products drawn annually from the forests amounts to over $1,250,000,000, which is 10 times the interest on the United States national debt, 12 times the annual gold and silver output, and four times the annual wheat product of the whole country.

A Wind Screen for Trains.—During an exceptionally heavy gale a passenger train in New Zealand was blown over an embankment, the engine alone remaining on the rails. In order to prevent a recurrence of such a disaster, a very strong palisade was erected to break the strength of the wind, which, when blowing in certain directions, rushes down the steep and narrow gorge, in which the line is constructed, with terrific force.

The Nicaragua Canal.—The construction of this canal will, it is said, follow closely upon the completion of the survey. The first work will be the building of a wharf at the harbour of Greytown, which may be utilised to land machinery, &c., needed for prosecuting the work. Mr. Maxwell, chief of the hydrographic party, and Mr. J. S. Ford are now engaged on this project. The borings on the site of the great dam show very favourably, rock and very tough hardpan being found throughout.

The Chicago Strike.—Traffic on the Michigan Central and the Fort Wayne and Belt Railroads has been resumed, the men returning unconditionally to work. The United States Court, in the case of the Belt Railway Company, delivered a decision by which the company was bound to handle the Burlington Company's cars. A general resumption of work is now expected, as the men are unwilling to lose their places in order to satisfy their leaders. All the strikes have now ended, excepting the original one on the Burlington Company's system.

To Erase Ink from Paper, &c.—The *American Druggist* publishes a recent patented composition for the removal and erasure of writing inks from paper, cloth, and all other substances, without injury to the substance. It is made as follows: to two quarts of water, which has been previously boiled and cooled, add four ounces of citric acid, and after the acid has been dissolved add six or eight ounces of a saturated solution of borax and twelve ounces of chlorinated lime. Place the whole in a stoppered quart bottle, shake well occasionally in the course of several hours, then allow to settle, and decant the clear liquid.

Steam Snow Shovels.—The rotary steam shovels appear to have done good work in clearing Western and North-Western roads of snow in the United States. On the Northern Pacific the switchback over the Stampede Pass was kept clear by the aid of one rotary, a feat which was regarded as impossible in the light of past experience. Many of the Northern Pacific branches in Minnesota and Dakota had been blocked for some weeks before the rotary shovels arrived from the East, but though the snow had been blown hard, and was full of sand and dirt, and frozen nearly as hard as sandstone, the rotary shovels successfully cut their way through, and enabled traffic to be resumed.

Petroleum Engine.—A new petroleum engine has just been exhibited in Sheffield by Messrs. Waterfall and Barber, of Bow Street. In a tank in the bed of the engine is placed the petroleum, which is forced through a pipe into a compartment where the oil is converted into a fine spray by means of a blast of air. The spray passes into a chamber, is rendered explosive, and, coming in contact with an electric spark—obtained from a small battery in the rear—motive power is at once supplied. In construction it is comparatively simple; it works with admirable regularity, and the piston requires no oiling, the petroleum vapour supplying the necessary lubrication.—*The Engineer.*

Extinguisher for Car Lamps.—According to *Engineering News* a Canadian by the name of Barry has invented an ingenious device for extinguishing car lamps in case of accident, which has recently been tested on the Boston and Lowell Railroad, and would seem to be simple enough to be worth adoption. A small reservoir under the car is charged once for all with compressed air from the brake pipes. Air can enter it at any time to keep up the pressure, but it can only escape through a valve operated by sliding weights, which are only caused to act by a violent collision or considerable tipping of the car. If they do act, the compressed air rushes through tubes to the top of every lamp chimney, blowing out the light.

Lock-Nuts for Permanent Ways.—Spring washers are primarily used here under the nuts of fish-plate bolts to prevent the nuts slacking back; but the *Railroad Gazette* says the practice in India and Australia, where the sun is very powerful, is somewhat different. Great difficulty has been experienced in these countries from the rails buckling in hot weather, the nuts being screwed up too tightly to permit the rails to slide longitudinally in the fish-plates. "The latest practice is therefore to prevent the nuts slacking by using lock or jam nuts, while a compressed spring washer exerts a fixed strain on the bolt, the amount of this strain being insufficient to clamp the fish-plates and rails immovably together. The latter can then move when expanded by the heat, and buckling is thus prevented. The *Indian Engineer* states that all Australian railways, except in Western Australia, use steel lock-nuts and steel bolts for splice bars, but they are not screwed up so tight as the old obsolete ordinary iron nut fastenings, which only depended on surface friction for their holding power, so that when eased off somewhat to prevent buckling they became a perpetual source of danger, besides running up the maintenance bill. In South Australia, where steel lock-nuts have been in use for ten years, no case of buckling has ever been known. A spiral spring of round steel is used under steel lock-nuts on some of the Indian roads. The nuts are not screwed up sufficiently tight to close the spring, which yields sufficiently to permit the expansion of the rails."

SELECTED PATENTS.

APPLICATIONS FOR LETTERS PATENT.

March 31st.

4844 Holders for Incandescent Lamps, W. P. Thompson, Liverpool. (N. E. Garczynski, ———.)
4848 Draught Regulator, W. H. Prestwich, Tottenham.
4851 Compression Pumps, J. K. Kilbourn, Liverpool.
4856 Valve, E. W. Donovan, Loughborough.
4858 Brakes, J. Smith, Bradford.
4860 Recording the Pressure of Steam, J. F. Abraham, Bradford.
4862 Reeling Machines, T. Holt, Manchester.
4867 Car Coupler, F. J. Hughes, Canada.—[Complete Specification.]
4868 Water Taps, T. Wilson, Birmingham.
4871 Regulating Flow of Liquids, W. Stuart and G. Young, Dundee.
4875 Machinery for Raising Submarine Telegraph Cables, A. Wilson and J. F. Tafe, London.
4888 Saws, F. Turrettini, London.
4897 Turning-off Machine, W. Campion, London.
4902 Railway Sleepers, H. H. Lake, London. (R. S. Sea, United States.)—[Complete Specification.]
4909 Telephonic Apparatus, J. C. Fell, London. (P. C. C. Otzen, Denmark.)
4910 Locks, S. Chatwood, S. R. Chatwood, and A. B. Chatwood, London.

April 3rd.

4917 Removing Incrustation from Boilers, H. Roberts, E. F. Roberts, and W. Holliday, Batley.
4918 Polishing Stone, J. Clyne and J. Mitchell, Aberdeen.
4919 Self-acting Mules, J. Clegg, of the firm of A. Lees and Co., Limited, and J. Moorhouse, Manchester.
4920 Valve Gear. J. W. Melling, Manchester.
4923 Punching Machines, I. Beck, Sheffield.
4925 Jacquard Machines, J. S. Smith and S. Smith, Glasgow.—[Complete Specification.]
4928 Brakes, R. Bardsley and J. Johnson, Manchester.
4929 Magneto-Electric Generators, W. Gillett and G. Haseltine, London.—[Complete Specification.]
4932 Thrust Blocks for Screw Propellers, G. Gilchrist, Glasgow.
4941 Rowlocks, W. H. Rice, London.
4944 Gas Engines, A. Wilson, London.
4951 Refining Iron, G. Lindenthal, London.- [Complete Specification.]
4961 Steam Boilers, A. J. Boult, Middlesex. (H. Rushton, Canada.)—[Complete Specification.]
4966 Taps, G. Petrie, Manchester.
4967 Gas Governors, H. E. A. Wallis, London.
4970 Signalling Apparatus, F. Stitzel and C. Weinedel, London —[Complete Specification.]
4971 Preventing Waste of Water, C. Kertsch, London.—[Complete Specification.]
4975 Manufacture of Iron, A. M. Warner, London.
4978 Machines for Pulverising Ores, H. H. Lake, London. (P. W. Gates, United States.)—[Complete Specification.]
4981 Steam Engines, S. E. Jarvis, London.—[Complete Specification.]
4984 Presses, E. Edwards, London. (P. J. Gayon, France.)
4986 Machinery for Stamping Mineral Ores, C. Appleby and G. E. Abrahams, London.

April 4th.

4994 Printing Machinery, W. T. Whiteman, Middlesex. (The United States Machine and Inventions Company, of New York, United States.)
5003 A Safety Lamp, T. R. Weston, Bristol.
5004 Propeller, W. Mitchell, Edinburgh.
5009 Weighing Machines, J. Cartwright and J. W. Cartwright, Manchester.
5012 Heating Feed Water of Boilers, I. S. McDougall, Liverpool.
5020 Packings for Piston Rods, T. Downie, Liverpool.
5030 Cock, P. A. Newton, Middlesex. (R. A. Christophersen, Denmark.)—[Complete Specification.]

April 5th.

5048 Engines, J. M. Fletcher, Chcadle.
5051 Lubricators, J. T. Hailwood, Rochdale.
5053 Steam Generator, W. P. White and R. Wallbank, Manchester.
5057 Steam Generators, I. S. McDougall, Liverpool.
5069 Electro Magnetic Motor, C. A. Randall, London.
5072 Valves, E. Knowles, London.
5076 Hoists, I. R. E. Birkett, Manchester.
5081 Cranes, J. Winter, Glasgow.
5083 Generating Steam, J. A. Walker, London.
5084 Manufacture of Steel, T. Twynam, Middlesex.
5090 Locks, B. Heimsoeth, London.—[Complete Specification.]

NOTICE TO NEWSAGENTS AND SUBSCRIBERS.

Numerous complaints having been made to us by Subscribers of the difficulty they experience in obtaining copies of the *Practical Engineer* in certain districts, we have to state that the Journal can be obtained by any Newsagent through the ordinary trade channels, and no difficulty should therefore exist in obtaining copies by order of any Newsagent.

For the information of the trade, we may state that copies can be obtained from either of our Offices in London or Manchester, or from any of the following wholesale houses.

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ABEL HEYWOOD & SON, Oldham Street, Manchester.
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J. MENZIES & CO., Drury Street, Glasgow.
W. LOVE, 236, Argyle Street, Glasgow.
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EDWARD KING, 37, Greyfriars Lane, Coventry.
&c., &c., &c.

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EDITORIAL NOTICES.

All communications for the Editor of this Journal should be addressed to 6, Victoria Station Approach, Manchester.

Communications intended for insertion in the current week's issue should reach us not later than Tuesday Evening.

We cannot undertake to return rejected manuscripts or drawings unless accompanied by a stamped and directed envelope.

Contributors are requested to write on one side only of the paper. Sketches should be sent on separate sheets.

TO ADVERTISERS.

Advertisements intended for insertion in the current issue should reach us on Wednesday morning at the latest.

Important Notice to Newsagents and Subscribers.

Our Publishing Offices in London are now at 11, PATERNOSTER BUILDINGS, E.C., where the Trade will in future be supplied.

Simultaneously with the above change, our PUBLISHING OFFICES in MANCHESTER have been REMOVED from Grosvenor Chambers, Deansgate, to more commodious and convenient premises at 6, VICTORIA STATION APPROACH, where all communications intended for the Manager or Editor should, in future, be addressed.

THE
PRACTICAL ENGINEER.
APRIL 20TH, 1888.

THE ARCHITECTS' AND ENGINEERS' REGISTRATION BILL.

UP to the time of writing, this unfortunate bill, which was set down for second reading on Wednesday, the 11th inst., had not been reached, and further evidence is continually coming to hand as to its unpopularity with those most interested, so that as time goes on its prospects of being carried appear to become more hopeless than ever. Not only have the mechanical engineers, as pointed out in our last week's issue, denounced it as likely to prove seriously detrimental to all interests in any way connected with the progress of mechanical engineering science and practice, but the civil engineers have declared against it also, and it is further opposed on behalf of the Royal Institute of British Architects, who object to the bill as one which they consider is such as could be only justified by the clearest proof that the Royal Institute had ceased to fulfil the duties for which it was incorporated.

Hence it is not very clear what is really desired by the promoters of the bill, except to make registration compulsory. One object is stated to be to put a stop to "jerry" building, but it is difficult to see how this would be attained, since the vast majority of houses and domestic buildings are not erected under the superintendence of architects, but of others who would really not be affected by the bill, and who would pursue their trade after the passing of the bill with the same impunity as before. If the "jerry" builder is to be reached—and certainly this term does not apply exclusively to those who build houses, but to engineers and others who scamp their work, and build inferior engines and boilers, for instance, also—it will have to be by seeing that those entrusted with the inspecting and sanctioning the use of the different structures are competent and efficient; and in this, so far as the officers appointed to inspect buildings by local or urban sanitary authorities are concerned, under whose control such buildings are placed, the Royal Institution of British Architects has announced that it is prepared to assist Parliament by extending or developing its examinations.

We do not see what really good object would be gained if the Architects' Registration Bill should become law, because it would never be tolerated that the public, whom it is sought to protect, should be prohibited in any way from employing or seeking advice from whomsoever they pleased; and it is not a very difficult matter, even at present, to ascertain by a little inquiry the merits of any professional man, even should he not be a member of any existing institution, such as the Royal Institute of British Architects, Institute of Mechanical or Civil Engineers, &c. The only object which would be served, apparently, would be to confer a kind of status upon mediocrity; and by registering such as are now practising as architects or engineers, who have either not the disposition or the necessary qualifications for becoming members of recognised existing institutions, a number of persons would be qualified to practise who have probably no special merit, and others would be excluded unless able to pass an examination to be instituted for all who may hereafter wish to enter the privileged circle. Such a result we do not consider is either desirable in the interests of the public or of engineering.

Since writing the above, we learn that when the bill was brought up for second reading on Tuesday night, and after being condemned by several speakers, amongst whom were Sir Lyon Playfair, Mr. Brunner, Mr. Giles, and the Attorney-General—the latter intimating that the Government thought the measure quite unnecessary—the bill was withdrawn and the order for second reading discharged.

SUPERVISION OF ENGINES AND BOILERS.

On the order for the second reading of the Steam Engines and Boilers Bill, which was reached in the House on Tuesday night, considerable discussion resulted. The object of the bill was to prevent anyone taking charge of a boiler or engine who had not obtained a certificate of competency. Most of the speakers who took part in the debate considered the bill would not prevent that kind of accident to steam boilers that resulted from carelessness; moreover, it would interfere with small trades and agricultural operations. Mr. Jacob Bright thought a much better bill would be one making the inspection of boilers compulsory. On a division, the second reading of the bill was negatived by 147 to 96.

NOTES.

Mr. Rothery, Parton, near Whitehaven, has brought out a tool for removing ferrules from boiler tubes, which consists of a wrought-iron pipe pressed against the tube plate by a nut traversing an inner steel tube. The latter tube is split for a considerable distance to give elasticity to the ends, which have projections at the ends for taking hold of the ferrule on its inside edge. A rod passes up the centre of the inner tube, and by its expanded end prevents the split tube projections slipping off the ferrule. The latter is easily extracted by rotating the nut on the inner tube.

A preliminary meeting will be held to-morrow evening at the Technical School, St. George's Square, Sheffield, to promote an engineering society in that town, with the object of discussing subjects of interest to engineers and others engaged in mechanical pursuits, and to provide opportunities of reading papers on technical subjects of local and general interest. It is proposed that the society, which will consist of members and associates, should meet once a fortnight.

LITERATURE.

A Manual of Marine Engineering. By A. E Seaton. 7th Edition. London: Charles Griffin and Company.

Mr. Seaton's manual has very deservedly become a standard text book on marine engineering, and no engineer's library can be considered complete without it. The seventh edition of the work has been enlarged with some new matter relating to triple expansion engines. The author, after referring to the great economy effected by this style of engine as compared to the older two-cylinder compound, attributes the superiority to—first, the higher steam pressure admissible; and secondly, to the avoidance of large initial strains, large variation of temperature, and large "drops" in the receivers. While fully admitting the first reason, we are far from subscribing to the second one if, by it the author means us to infer that there is less condensation in the cylinders, inasmuch as the heat trap theory has never yet been satisfactorily proved. As a matter of fact, notwithstanding the diminished range of temperature in each cylinder owing to the division of the total fall between three cylinders instead of two, there is more condensation in the first cylinder of a triple expansion engine than in that of a two-cylinder compound, and hence the very reverse of what would be reasonably expected from the heat trap theory actually occurs. Whatever the cause may be, the fact remains that the three-cylinder engine working at 140lb. pressure is 25 per cent more economical than the two-cylinder engine working at 90lb.; and it is not therefore surprising that all new marine engines should be built on this principle. Besides the matter of economy, the triple expansion engine has less wear and tear, notwithstanding its additional working parts, and the strain on the piston rods is also smaller in engines developing the same power. Mr. Seaton treats of these matters in an appendix, and in this edition he has also embodied the latest regulations issued by the Board of Trade and Lloyd's Registry.

SOME PRACTICAL NOTES ON MARINE ENGINEERING.—XIII.

(*Continued from page* 159.)

Design and Construction of Boilers.—II.

FLAT SURFACES.

End Plates and Combustion Chambers.

The flat ends have usually double riveted lap joints, except in small boilers, say up to 9ft. diameter, when they have sometimes single riveted joints, though boilers are now made up to this diameter with the end plates in one piece.

The combustion chambers are all single riveted except at the bottom seam to furnace, which should always be double. The seam joining the back tube-plate to furnace may be either single or double riveted.

The strength of flat surfaces is considered according to the following formulæ, one being that used by Lloyd's, and the other that by the Board of Trade:—

$$\frac{C \times T^2}{P^2} = \text{working pressure.}$$

where C = 160 for plates fitted with stays and double nuts and riveted washers.
140 for plates fitted with stays and double nuts.
120 for plates above $\frac{7}{16}$ fitted with screwed stays and nuts.
110 for plates $\frac{7}{16}$ and under fitted with screwed stays and nuts.
100 for plates above $\frac{7}{16}$ fitted with screwed stays and riveted heads.
90 for plates $\frac{7}{16}$ and below fitted with screwed stays and riveted heads.

P = greatest pitch in inches.
T = thickness of plate in sixteenths.

Sometimes the ends in steam space are fitted with doubling strips (see sketch, pages 541 and 564 *Practical Engineer*, Vol. I.), for which due allowance must be made. When the end is entirely doubled the value of T^2 of this plate must be added as explained below.

Board of Trade formula $\frac{C \times T\,(+\,1)^2}{S - 6}$

$$\text{where } C = \left.\begin{array}{l}200\\187{\cdot}5\\125\\112{\cdot}5\end{array}\right\}\text{ for steam space stays, as explained lower down.}$$

For end plates in steam space the stays are usually pitched from 13in. to 18in., and the plate is from $\frac{5}{8}$ to $1\frac{1}{16}$ thick, the former being for small boilers, and fitted with a riveted doubling strip, or entirely doubled by a plate. Thus say, $\frac{5}{8}$ end and $\frac{5}{8}$ doubling for 160lb. pressure, pitch of stays

$$= \sqrt{\frac{(10^2 + 10^2) \times 160}{160\text{lb.}}} = 14{\cdot}1\text{in. for a plain } \tfrac{7}{8} \text{ end } \sqrt{\frac{14^2 \times 140}{160\text{lb.}}}$$

$$= 13\text{in. or a plain 1in. plate} = \sqrt{\frac{16^2 \times 140}{160\text{lb.}}} = 15 \text{ nearly.}$$

COMBUSTION CHAMBERS.

These plates are never less than $\frac{7}{16}$, and have been up to $\frac{5}{8}$ thick; the latter is, however, rather heavy; $\frac{1}{2}$, $\frac{17}{32}$, or at most $\frac{9}{16}$, answer well. Nuts are fitted inside, and generally on the outside of shell as well; but the latter may be riveted over without detracting from the value of the inside—that is, in the fire box. Say $\frac{1}{2}$ plate for 160lb. $= \sqrt{\frac{8^2 \times 120}{160}} = 6{\cdot}92$, or, say, 7in. pitch of stays; but if this in a wide fire box, with three or more rows, gives a less section where the stays pass through the shell at sides, than there is between the outside row of rivets in the longitudinal joint, then the combustion chamber plates must be increased in thickness to meet the section required, otherwise the percentage of plate for strength of shell would have to be based on the pitch of these stays. Thus, if we had $7\frac{3}{8}$ pitch, with $1\frac{1}{4}$ rivets = 83 per cent, the combustion chamber plate would have to be $\frac{9}{16}$ thick; then $\sqrt{\frac{9^2 \times 120}{160}} = 7\frac{3}{4}$ pitch of stays.

By the Board of Trade rules, a plate entirely doubled is to be submitted for the consideration of the Board, and we therefore cannot say what the calculation would be; but a $\frac{5}{8}$ plate as above, with a doubling strip $\frac{5}{8}$ thick, and in width not less than $\frac{2}{3}$ of the pitch of stays $= \frac{121 \times 200}{160} = 156$ square inches $= 12\frac{1}{2}$ pitch, or $14{\cdot}1 \times 11{\cdot}6$ when compared with that given above. A plain $\frac{7}{8}$in. plate $= \frac{225 \times 112{\cdot}5}{160} = 164$ square inches $= 12{\cdot}8$ pitch, or $13 \times 12{\cdot}6$. A plain 1in. plate $= \frac{289 \times 112{\cdot}5}{160} = 209$ square inches, or $14{\cdot}5$ pitch, or 15×14. If fitted with riveted washers, the constant would be 187·2, and if with large plain washers, 125.

For combustion chamber plates the constant is 100 when nuts are fitted. Thus for $\frac{1}{2}$ plate $\frac{81 \times 100}{160} = 56{\cdot}6$ square inches, or $7\frac{1}{2}$ pitch.

STAYS.

For steam space stays above $1\frac{1}{2}$in. diam. 9,000lb. per square inch; for all screwed and other stays less than $1\frac{1}{2}$ diam. 8,000lb. per square inch.

Iron stays, not welded, 7,500lb.; screwed stays and others less than $1\frac{1}{2}$ diameter, 6,000lb.

The stays are usually of steel, those in the steam space and other long stays being from 2in. to 3in. diameter; the screwed stays are from $1\frac{1}{8}$ to $1\frac{3}{4}$ diameter.

According to the above, and for 160lb., the diameters and area supported will be as shown in the following table:—

$$\text{Area of stay} = \frac{\text{supported area} \times 160\text{lb.}}{S}$$ where S = the strain to be allowed.

Outside Diameter of Stay.	Diameter of Stay at smallest part.	Area of Stay at smallest part.	Kind of Stay.	Area it will support.		Pitch of Stay.	
$3\frac{1}{4}''$	3	7 sq. in.	Solid, fine thr'd	394 sq. in.		$19\frac{7}{8}$ in.	
$3''$	2·8	6 ,,	,, ,,	337 ,,		$18\frac{3}{8}$,,	
$2\frac{3}{4}''$	2·56	5·2 ,,	,, ,,	292 ,,		17 ,,	
$2\frac{1}{2}''$	2·31	4·2 ,,	,, ,,	236 ,,		$15\frac{3}{8}$,,	
$2\frac{1}{4}''$	2·06	3·35 ,,	,, ,,	188 ,,		$13\frac{11}{16}$,,	
$2''$	1·8	2·54 ,,	,, ,,	143 ,,		12 ,,	
				solid	screwed	solid	screwed
$1\frac{3}{4}''$	1·56	1·9 ,,	Both ,,	107	95	$10\frac{5}{16}$	$9\frac{1}{4}$
$1\frac{5}{8}''$	1·46	1·62 ,,	,, ,,	91	81	$9\frac{1}{2}$	9
$1\frac{1}{2}''$	1·31	1·35 ,,	,, ,,	67·5		$8\frac{3}{16}$	
$1\frac{3}{8}''$	1·18	1·12 ,,	,, ,,	56·		$7\frac{1}{2}$	
$1\frac{1}{4}''$	1·06	·89 ,,	,, ,,	44·5		$6\frac{11}{16}$	
$1\frac{1}{8}''$	·94	·7 ,,	,, ,,	35·		$5\frac{15}{16}$	

FURNACES.

For corrugated and ribbed furnaces the pressure is calculated as follows: The corrugations to be $1\frac{1}{2}$in. deep.

$$\text{Lloyd's } \frac{1000\,(t - 2)}{D} = \text{working pressure.}$$

where D = outside diameter in inches, and t = thickness in sixteenths.

$$\text{Board of Trade } \frac{12{,}500 \times T}{D} = \text{working pressure.}$$

where T = thickness in inches, and D = mean diameter in inches, the thickness not to be less than $\frac{5}{16}$ and the plain parts at ends not to exceed 6in.

STRIKE OF IRON MOULDERS IN HULL.

On Monday week the iron moulders employed at the works of Messrs. Earle's Shipbuilding and Engineering Co., Charles D. Holmes and Co., Amos and Smith, The "Old Foundry" (Messrs. Rose, Downs, and Thompson), Messrs. Priestman Brothers, and Good and Menzies—constituting in all a little over two-thirds of the total number of iron moulders in Hull—came out on strike, as the masters have refused to accede to their request for an increase of 2s. per week in their wages.

It appears that in 1884, owing to the depressed state of the iron trade, a reduction of 2s. per week was made, and at the same time a promise was given that when trade revived the money should be restored to its original amount. The men contend that the present state of trade is such as to warrant them in applying for the restoration of their previous rate, but the masters have taken their stand, and assert that the amount of trade is not so great, and the monetary value is by no means so large as it was in 1884, and they say that owing to the severe competition which now exists they do not feel justified in acceding to the men's demands.

It is much to be regretted that some settlement could not have been made, as it must certainly be a serious matter for both sides, and each will no doubt, to some extent, suffer in consequence. We understand that there are no non-society men in the town and the firms affected by the dispute will no doubt be driven to the necessity of obtaining their castings from other districts, and as many of the men have since obtained employment in other towns, a certain amount of time must elapse before things can be restored to their original state, and before the spirit of ill-feeling and discontent which must have arisen in consequence of the strike can be conquered. The men say that the rate of wages paid in Hull is small when compared with that of other manufacturing districts; but the masters have pointed out that, on the other hand, it should not be forgotten that the amount paid in Hull is higher than in some shipbuilding centres, and also that in comparing the wages which moulders obtain in Hull with that of the men in places where a higher rate obtains, it must be remembered the "money value" in Hull is better than in the said districts, as house rent and provisions, &c., in Hull are, comparatively speaking, abnormally low.

We understand that before the dispute dry-sand moulders received 32s., and loam moulders 34s., per week of 54 hours. It is rumoured that the men in the other departments intend taking the necessary steps to obtain their previous rate of wages. Both sides claim that they are prepared to fight to the bitter end.

We may just mention that in the smaller shops in the town, employing in all an aggregate of about sixty men, the dispute does not exist, as some of these men have all along received the full money, and the others have been able to obtain what they desired. The masters are taking active steps to prevent, as far as is possible, any serious inconvenience with respect to the work they have in hand, by sending work away to other places, where, they assert, they are able to purchase castings at as cheap, if not a cheaper rate, than they are able to produce them themselves.

LESSONS IN MECHANICAL DRAWING.—XV.

By Prof. A. MacLay, B.Sc., C.E.

ON THE USE OF SQUARED PAPER.

In the last set of exercises (Lesson XIV., p. 147) the student was required to plot the curves representing the experimental results given in Tables I. to VI., by exact scaling. In actual practice, however, such results are more often plotted out on prepared sheets of "squared paper," *i.e.*, on paper in which horizontal and vertical lines have been ruled close together, so as to cover the whole surface with little squares, after the manner of figs. 75 and 76 in last lesson. Also, every tenth vertical and horizontal line is made thicker or heavier, so as to guide the eye in glancing along from the side, top, or bottom indices.

Evidently we may use these divisions of the paper precisely in the same way as we have before used the divisions of a scale. In fact, "squared paper" might as well be called "scaled paper," for each horizontal and vertical line on the paper is now a fully divided scale of units, and we can use these units of length of the paper to represent the units of quantity in the tables, precisely in the same way as has been done already with scales. For example, in the stress and strain diagrams of exercises Nos. 57 and 61, instead of an inch per ton we may now take say, ten unit divisions of the squared paper per ton, the only difference being that we cannot now plot so exactly as we could do before when taking the measurements from a diagonal scale.

In the last series of exercises curves of stress and strain were illustrated. The following will give the student some practice at the use of squared paper, and at the same time illustrate one or two curves other than those he has already drawn, such as those of pressure and volume, motion and resistance, composition and strength. For these the student should either prepare or purchase some sheets or a book of squared paper. We will assume the sheet not to exceed 10in. × 10in., and the lines to be ruled at distances of $\frac{1}{10}$in. apart.

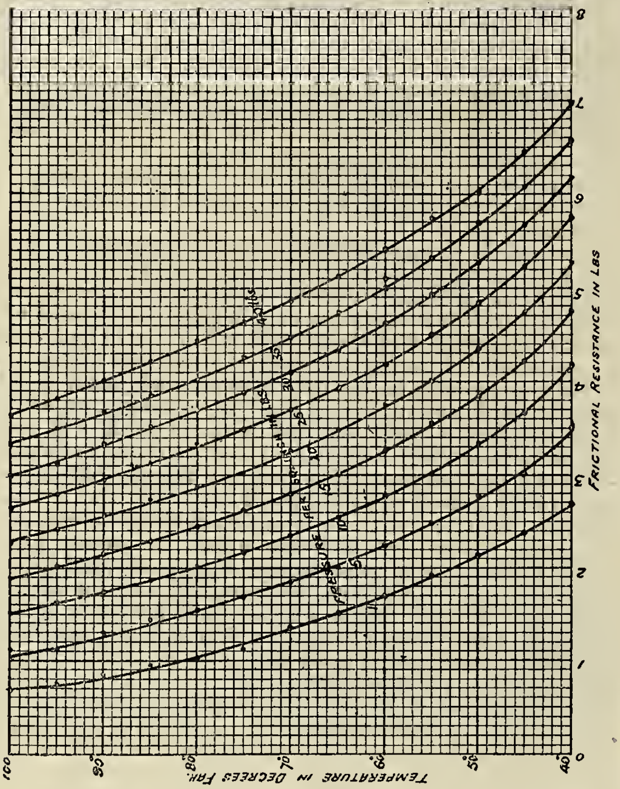


Fig 78

Exercises.

Ex. 66.—From the figures in Table VII. draw a curve showing the relation between the pressures and volumes of 1lb. of saturated steam. Take 2lb. pressure and 1 volume per unit of length.

Table VII.*

Press. per sq. in.	Volume in cub. ft.	Press. per sq. in.	Volume in cub. ft.	Press. per sq. in.	Volume in cub. ft.
150	2·96	70	6·07	20	19·72
140	3·16	60	7·01	17	22·96
130	3·38	50	8·31	14·7	26·36
120	3·65	45	9·18	12	31·88
110	3·97	40	10·27	10	37·84
100	4·33	35	11·65	8	46·69
90	4·79	30	13·46	6	61·21
80	5·35	25	15·99	4	89·62

* From Table No. 128 D. K. Clark's "Manual of Rules, Tables, and Data."

Ex. 67.—Draw the curve of resistance at different speeds shown by the figures in Table VIII. Plot to 20 units per mile of speed (beginning with 5 at the zero point), and 10 units per 100lb. of resistance (beginning with 300 at the zero point).

Table VIII.†

Speed of Vessel in miles per hour.	Resistance in lbs.	Speed in miles per hour.	Resistance in lbs.	Speed in miles per hour.	Resistance in lbs.
5·0	315·4	6·2	490·4	7·4	836·5
5·1	323·3	6·3	513·2	7·5	867·1
5·2	333·2	6·4	536·9	7·6	895·8
5·3	344·1	6·5	560·6	7·7	920·5
5·4	356·0	6·6	587·3	7·8	946·3
5·5	368·8	6·7	616·0	7·9	967·0
5·6	380·7	6·8	644·7	8·0	990·8
5·7	397·5	6·9	676·3	8·1	1009·5
5·8	414·3	7·0	707·0	8·2	1027·3
5·9	431·1	7·1	739·6	8·3	1043·2
6·0	449·9	7·2	773·2	8·4	1057·0
6·1	470·7	7·3	805·8	8·5	1082·4

† From experiments by B. F. Isherwood, U.S.N. Engineering, xx., 368.

Ex. 68, Fig. 78.—Table IX. contains the record of dynamometer readings, showing the frictional resistance of a paraffin oil as tested between two discs in a special machine, at a series of pressures of from 1lb. to 40lb. per square inch, and temperatures from 40° to 100° Fah. Draw a series of curves showing the relation between the pressure, temperature, and frictional resistance, as given by the figures in the table. Plot to 1 unit of length per degree of temperature, and 10 units of length per lb. of resistance.

Table IX.*

Pressure in lbs. per sq. inch.	Temperatures.												
	40	45	50	55	60	65	70	75	80	85	90	95	100° F.
	Resistance to Friction.												
1	2·69	2·39	2·13	1·91	1·70	1·51	1·34	1·19	1·06	·95	·85	·75	·69
5	3·50	3·08	2·76	2·49	2·25	2·04	1·85	1·69	1·55	1·43	1·30	1·19	1·09
10	4·18	3·66	3·33	3·03	2·77	2·54	2·34	2·17	2·01	1·86	1·74	1·62	1·51
15	4·75	4·21	3·85	3·55	3·26	3·02	2·80	2·61	2·44	2·29	2·15	2·01	1·88
20	5·28	4·73	4·35	4·03	3·75	3·49	3·27	3·07	2·89	2·73	2·57	2·41	2·27
25	5·75	5·22	4·83	4·50	4·19	3·93	3·70	3·49	3·31	3·13	2·95	2·79	2·63
30	6·19	5·67	5·28	4·92	4·61	4·33	4·10	3·88	3·69	3·51	3·34	3·15	2·99
35	6·58	6·08	5·69	5·32	5·01	4·73	4·48	4·26	4·05	3·86	3·68	3·50	3·32
40	6·97	6·46	6·06	5·73	5·41	5·12	4·86	4·63	4·42	4·21	4·02	3·82	3·62

* From "Experiments on Lubricating Oils," by C. J. H. Woodbury (Amer. Soc. Mech. Eng., 1884).—*Engineering*, xxxviii, 534.

Table X.†

Percent'ge of Silicon.	Relative Density.	Relative Hardness.	Tensile Strength per sq. in.	Crushing Strength per sq. in.	Transverse Strength.	
					Central load on bars 1ft. long and 1in. sq.	Modulus of Rupture (calculated).
A	B	C	D	E	F	G
			Tons.	Tons.	Tons.	Tons.
·19	7·719	72	10·14	75·30	1·206	21·708
·45	7·670	52	12·31	91·42	1·464	26·352
·96	7·630	42	12·72	92·54	1·504	27·072
1·37	7·473	..	14·04	82·08	1·561	28·098
1·96	7·350	22	15·70	61·29	1·538	27·684
2·51	7·388	22	14·62	77·18	1·577	28·386
2·96	7·279	22	12·23	57·45	1·272	22·896
3·92	7·218	27	11·28	47·74	1·135	20·430
4·74	7·170	32	10·16	46·16	1·046	18·828
7·33	7·138	42	5·34	49·55	0·672	12·096
9·80	6·924	57	4·75	34·10	0·559	10·062

† From experiments by T. Turner, "Jour. I. and S. Inst.," No. 1, 1886.

Ex. 69.—From Table X. plot in the one diagram curves of relative density and hardness, and curves of tensile, crushing, and transverse strength, to show the effect of silicon on the properties of cast iron. Sheet, say 10in. × 10in. Scales: For columns A, B, F, take 10 units of length per unit to the left of the decimal point in the column; for columns C, D, E, G, take 1 unit of length per unit to left of decimal point.

[Note that when curves of different kinds of properties of a material are to be shown in the one diagram, they need not be drawn to the one scale, since the results have only a value relative to the figures in the first column, and are not comparable in amount, as for example columns

B, C, and D, in Table X. But the same does not apply to columns D, E, and G, which represent various phases of the one property—strength—and should, therefore, be drawn to the one scale, in order that they may be readily compared among themselves.]

SNOW EXCAVATOR FOR RAILWAYS.

A new device for clearing railroad tracks of snow (says the *Railroad Gazette*) has lately been patented in the United States and Canada, and it is the intention of the owners of the patents to immediately begin the construction of machines and to fill orders for next winter.

The essential feature of the machine is a revolving fan wheel, about 9ft. in diameter, mounted on a horizontal shaft. The fan wheel carries longitudinal knives and vanes—the knives to cut the snow and ice, and the vanes to carry it back into a chamber, from which it is thrown out by the centrifugal force and the air current established. The fan wheel, which will make from 200 to 250 revolutions per minute, is actuated by two engines, placed with a boiler on the car and connected to cranks on the ends of the shaft. The case enclosing the after portion of the fan wheel fits close to the ends of the vanes, and communicates directly with the spout above, through which the snow is discharged. The snow is thus retained in contact with the vanes until it is discharged vertically through the spout. The spout is provided with two curved deflecting plates, which direct the stream of mingled snow and air toward one side of the car. These plates are so arranged that they may be slipped backwards out of the spout, and the same operation draws in another set of plates, curved in the opposite direction, which deflect the current to the opposite side, thus changing the delivery of the snow from one side of the track to the other at will. This change can be effected while the machine is in motion and without bringing the car to a standstill or lessening its speed. An ice breaker and flanger is also placed in front of the first pair of wheels of the car carrying the apparatus. The whole is pushed forward, as is the rotary, by one or more locomotives behind it, and the car is provided with a steam brake. The machine has many points of advantage over any other machine previously introduced.

MOVING THE BRIGHTON BEACH HOTEL.

The task of moving a great hotel 500ft. is so singular and unprecedented that it has excited much interest, and though the difficulties of such an undertaking may appear insuperable, the means employed are very simple, and ultimate success is practically assured. Many eminent engineers foretold failure, and those responsible for the plan of operation adopted are therefore to be congratulated on having the courage of their opinions and the skill to justify their judgment.

The Brighton Beach Hotel, which has been hauled part of its inland journey of 500ft., is a wooden structure of irregular form, resting on brick walls rising about 5ft. above the ground level. The extreme length of the building is 460ft., the extreme width 200ft., and the minimum width is about 150ft. Part of the structure has five stories, and the estimated total weight that had to be moved is given as 5,000 tons.

This hotel is one of three great hotels at Coney Island, and is about 9½ miles from the City Hall of New York by the most direct route. The sandy shore on which the hotel stands has been washed away, and the high-water line has advanced about 550ft. in the last five years. The waves had gradually underminded the hotel.

It was evident that three usual courses were open. Either the encroachments of the sea might be prevented by efficient sea walls, or (2) the hotel might be taken down and rebuilt further inland; or (3) the hotel might be moved bodily. The latter course was finally determined on. The distance to be traversed, 500ft., and the weight and size of the hotel, rendered the ordinary methods of using jacks, &c., inadvisable, but it was deemed feasible to place the weight of the hotel on a large number of strong freight cars placed on parallel tracks, and haul them by several locomotives.

Twenty tracks were laid under the hotel, and were supported partly on piling and partly on a series of sawn balks and ties laid on the natural surface of the ground. These tracks were carefully levelled by means of shims, and holes being cut in the brick walls supporting the hotel, iron gondola cars were placed underneath the hotel. Six cars were placed on each track where the hotel was widest, and four cars were placed under some of the wings where the hotel was only 150ft. wide. The cars were of peculiar construction, the sills being composed of wrought-iron tubes, with cast distant-pieces, truss rods, clips, &c., all bolted together and disposed in a somewhat singular and ingenious fashion. The end sills especially attracted attention, being apparently chiefly composed of thin steel castings of box section, freely lightened by perforations of ornamental pattern and design.

The 112 cars used in this case had a nominal capacity of 50,000lb. each, but probably sustained an average weight of fully 80,000lb. each. Timbers about 12in. square were placed across these cars, resting in most cases on the sides, and not on the floors of the cars. The weight of the hotel was gradually transferred to these timbers by means of shims, wedges, and packing pieces, and to some extent the timbers were connected and braced together, so as to distribute the various strains and cause the hotel and cars to move as one structure.

The twenty tracks being levelled, and the load as far as could be judged equally distributed on the 112 cars used, the next step was to divide the hauling power of the locomotives, so that the pull on each set of cars would be tolerably equal. This was accomplished by an arrangement of blocks and tackle. A double line of heavy balks laid behind the blocks braced the different tracks together, and prevented any tendency of the road to rise. Corresponding blocks being attached to the drawbars of the cars, the falls were led off, passing through single snatch blocks attached to some of the cars. It was estimated that the locomotives would move 6ft. to move the hotel 1ft. About three tons or nearly two miles of new 1½in. manilla rope were employed.

Six ordinary American type passenger engines were employed, three locomotives on each track. The falls radiated to the locomotives, and as some of the falls from the western portion of the building led to the locomotives standing on the eastern track, and *vice-versa*, the resultant pull on the locomotives was practically parallel with the track.

The total weight to be moved, including hotel, cars, and locomotives, may be taken at about 13,000,000lb., or 6,500 tons. The wheels and rails being somewhat rusty, and the cars having been standing for a considerable time, the resistance was probably considerable, and, without making any allowance for the friction of the ropes and blocks, may be taken at fully 15lb. per ton. The total resistance would therefore be 15 × 6,500 = nearly 100,000lb. The arrangement of the ropes and pulley blocks was such that the nominal leverage of the engines was 6·1, and as six engines were employed, it would appear that, neglecting the friction of the blocks, &c., a tractive force of only $\frac{100,000}{36} = 2,777$lb. exerted by each locomotive would keep the hotel moving. Probably this amount was fully doubled by the friction of the ropes and blocks, but it was evident that the engines were fully equal to their task.

The maximum distance the hotel was moved at one pull was 67½ft., which was traversed in about three minutes. The hotel was moved a total distance of about 117ft. on Tuesday, April 3, and a somewhat greater distance on the next day. A halt was then made, and the track already traversed will be taken up and laid in front for further progress. The speed whilst in motion was about 20ft. per minute. The hotel has so far been uninjured, and it is stated that not even a ceiling has cracked or a pane of glass been broken, though all the windows are in place. The hotel moved without vibration, and the whole proceedings were conducted very quietly and with a commendable absence of fuss or excitement. The work of preparation was begun last November.—*Railroad Gazette.*

Bolton Engineers.—At Bolton, on Monday, it was announced that the local employers in engineering trades, who are exceedingly busy, had voluntarily conceded their 2,000 people an advance of 2s. weekly, for which the men were last year out on strike for six months, losing £50,000 in wages, and bringing upon the town an expenditure of £11,000 for extra police and military. The advance, which is equal to the reduction made in February, 1886, is to take effect from July next.

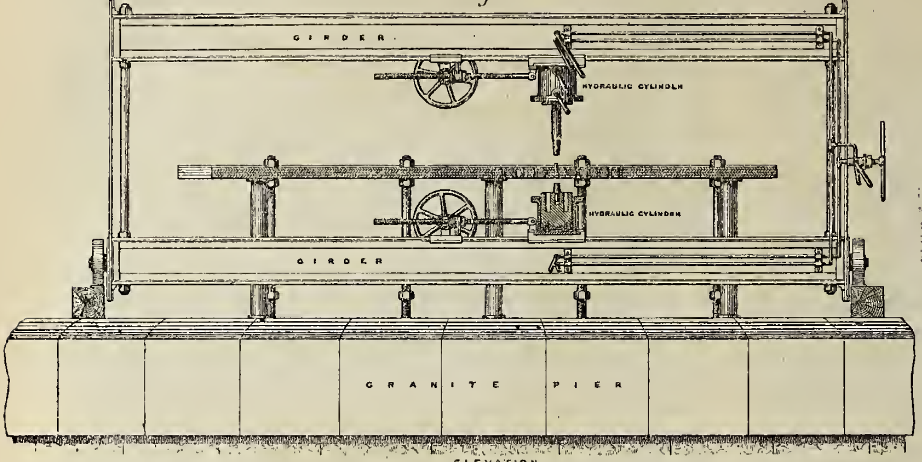
Car-heating by Steam.—The Oregon Railway and Navigation Co. (says the *National Car and Locomotive Builder*) have been experimenting with car-heating by steam on plans of their own, but the arrangement has not turned out to be profitable. One of the heaters got frozen up on a car that was in the shops at Portland. In trying to thaw it out the car was set on fire, and the fire spread to the building, burning down the shops, consuming in the ruin a number of locomotives and cars, besides other valuable machinery.

HYDRAULIC APPLIANCES AT THE FORTH BRIDGE WORKS.—II.

By Ernest William Moir, Stud. Inst. C.E.

(Continued from page 163.)

Fig: 4.



ELEVATION

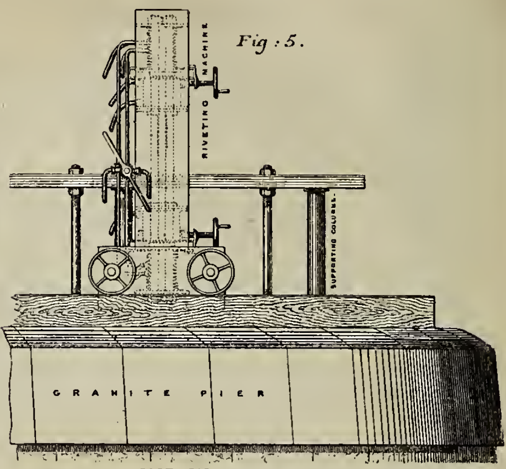
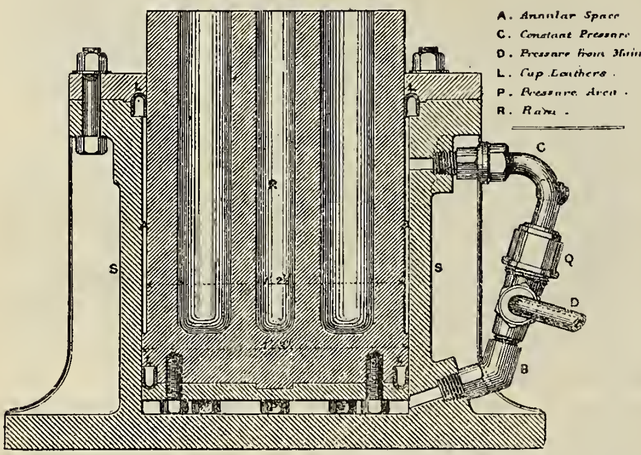


Fig: 5.

PART SIDE ELEVATION.

METHOD OF RIVETING LOWER BED PLATE.

Fig: 6.



HYDRAULIC JACK.

The thickness and the number of courses of plates in some portions of the bridge is so large, and the necessity for machine riveting therefore so great, that special plant had to be made for the work. Figs. 4 and 5 represent the machine used for riveting the upper and lower bed-plates, which rest upon the tops of the granite piers supporting each cantilever. The bed-plate is supported on columns about 4ft. 6in. above its final level.

The machine is composed of two box-girders bound together at their ends by bolts and plates, and faced on their inner surfaces. Each girder is provided with a cast-steel slide, having a planed recess at right angles to its longitudinal axis. The base of a 12in. cylinder is contained within the slide, and can be moved transversely, or longitudinally by suitable screw-gearing.

The whole machine travels on wheels at its ends, which rest upon timber runners having "flats" spiked to their upper surfaces.

Both the cylinders are controlled by one cock, to which six pipes are attached; two of these are for the main pressure and exhaust, and two for each cylinder. Only one of the two entering each cylinder is controlled by the valve, that which enters it nearest the base; to the other the high-pressure water has constant access. The use of these two connections will be better understood by referring to fig. 6, which is a section of a 15in. hydraulic ram, used in the works for the setting of heavy plates, and connected in the same way as the riveting cylinders. S, the cylinder, has two connections coming from the cock, Q, one, B, on the under side of the piston, and one, C, on the upper side of the same. The lower one only can be controlled by the cock, the water being always free to enter the upper one. There are two cup leathers, L; the upper one, which is always in action, faces downwards, and L′, which faces upwards, only comes into use when the water is allowed to escape from the under side of the ram, R; for in that case the pressure is no longer equal on both sides of the leather, expanding it at the same time the pressure in the annular space in the front of the piston forces in the ram. On again admitting the water to the under side of the ram, the pressure becomes equal on both sides of the lower cup leather, and the lifting area of the jack is that due to the smaller diameter.

With the above riveter eleven hundred rivets, $1\frac{1}{8}$in. in diameter, and from $5\frac{1}{2}$in. to 6in. long, have been put in in one day of ten and one-quarter hours. In the complex junctions of the tubes, where it is impossible to work one of the ordinary riveting machines, but where it is a matter of importance to secure the advantages of hydraulic over hand riveted work, it was necessary to devise something entirely new. Whatever mechanism was employed would require to be of such dimensions that it would pass through a manhole 16in. by 13in., and of such a weight as to be easily handled by one man. Mr. Arrol decided to adopt a high pressure with a correspondingly smaller piston area, and it was found that with a pressure of 3 tons per square inch, a riveting cylinder of 4in. in diameter was sufficiently powerful to do the work; the weight of such a cylinder and fittings does not amount to more than 40lb., and its overall dimensions are only 10in. by 6in.

MACHINES FOR PATTERN SHOPS.—IV.

(Concluded from page 164.)

PLANING MACHINES.

Planing machines for wood are of several kinds, embracing those in which the timber is surfaced by means of gouge-like cutters set in the face of a *disc* and revolved rapidly across the face of the work; those having fixed irons only, like very broad plane irons, held in a box, the wood being driven over the fixed edge; and those having two or four broad cutters set in a revolving adze block. This last is by far the most important class of cutters, and that most generally employed. Seeing that the knives have a speed at the periphery of about 6,000ft. per minute, the nicest balancing is necessary to prevent waviness of surface on the wood being planed, and the truest fitting of bearings, together with ample length of bearing surface, must be provided in order to prevent heating. Machines constructed with these blocks are broadly divisible into two great classes—the "roller feed," and the "hand feed." In the first the timber is fed along with broad, heavy serrated or fluted rollers of iron, set in motion by suitable gearing; in the second the hands alone are employed to feed the timber over the cutters. Of the heavier machines in the first class we need have nothing to say, as they are designed for a heavier and more regular class of work than that done in pattern shops, so we confine our remarks to the lighter hand, and power feed machines alone.

Of the two machines selected for illustration, fig. 9 is a hand-feed planer, made by Messrs. Geo. Richards and Co., Limited. The other, fig. 10, is a combined hand and power feed machine with superimposed tables, made by Messrs. Robinson, of Rochdale. These are the best types of machines for pattern work. In fig. 9, the stuff being passed by hand over the revolving cutter block is

MACHINES FOR PATTERN SHOPS.—IV.

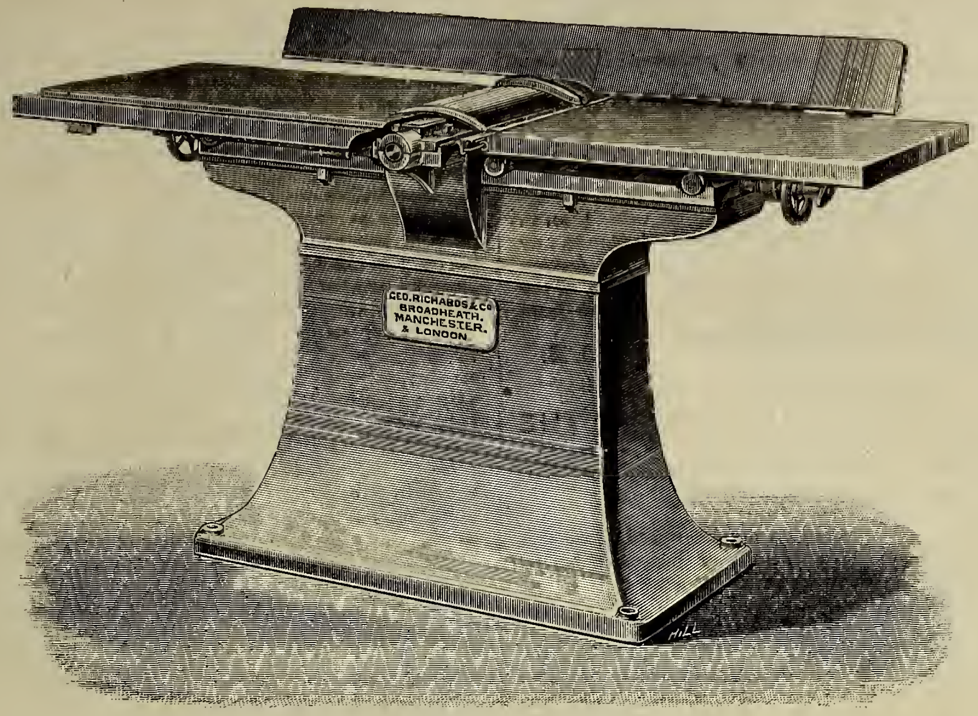


Fig. 9.—GEORGE RICHARDS & CO., BROADHEATH.

planed true and free from wind, simply because it is under no coercion other than that afforded by the slight pressure of the attendant's hands. But in the case of roller-feed machines the board is pressed down upon the cutters with considerable force, and therefore any initial wind present in the rough board remains after it is planed over. For this reason, therefore, hand-feed machines are properly required in pattern shops, since pattern stuff must be planed out of wind, or true castings will not result. A moderate amount of wind which would not be detrimental in flooring boards, match boarding, panelling, &c., would be highly objectionable in pattern work, where such extreme accuracy in this respect is usually essential.

In fig. 9, and in the upper table of fig. 10, as well as in all machines of this character, the depth of cut is regulated by lowering the table in relation to the cutter block. The table is made in two portions, divided next the cutter block, and the arrangement is such that for any depth of cut the distance between the edge of the table and the knives remains constant; the smaller the opening left, the better. The method of effecting this movement is a secondary matter, and is variously carried out; but the arrangement itself is important, a wide opening being detrimental to clean and safe working.

Machines of this class, though suitable for planing wood truly on the face, are not adapted for planing to a parallel thickness, except in a tentative fashion. But most pattern-makers' work has to be thicknessed, almost the only exceptions being the inner faces of core boxes and of battens, and the exterior faces of boxed-up work, which form a comparatively small section of the total quantity of work done. For this reason, therefore, the combination panel planing machines are, on the whole, preferable to the simple hand-feed planers. Of these there are several types, but I should give preference to one of the class shown in fig. 10, in which machine the stuff, being first surfaced out of wind on the top table, is thicknessed on the lower table. In many, perhaps in most panel planers, there is but one table used, and the stuff is carried over by means of fluted rollers above. These machines will thickness, but will not plane out of wind, for if the stuff is winding or hollow before it goes in, it will, when thicknessed, be also winding or curved to the same amount that it was in the rough. There is yet a class of combination planers used in which a rising and falling table is employed, the wood being traversed over the cutters by hand, the table being suitably elevated, and then again passed beneath the cutters by serrated rollers, the table being lowered accordingly. Whatever particular machine is selected, the choice should properly lie between the combination machine and the simple hand planer, since the mere thicknessing is of less value in pattern work than the planing out of wind. For a small shop, therefore, a hand-feed planer should be selected like fig. 9, in preference to a panel planer simply; but where the work will pay for the additional outlay, then fig. 9 and a panel planer should be chosen, or otherwise a combination of the two, like fig. 10.

Respecting taper, there is no machine which will plane even the bulk of the taper required in pattern work. Where stuff is thick, so that the edge bears a very sensible relation to the width, taper can be planed by canting the fence, which is shown in both figures alike; but taking wide boards of ½in., ¾in., or 1in. in thickness, the taper of $\frac{1}{16}$in. or ⅛in. in the thickness can only be given by the hand-planes following after the machine. Edges, however, can be planed square or bevelled by guiding the surface of the stuff against the properly adjusted fence, the edge passing over the cutters. Speaking of edges, we observe one noteworthy point about the machine shown in fig. 9, viz., the guard placed over the cutter-block to prevent possible injury to the fingers of a careless workman. This is of sheet iron attached to a sliding piece in front of the cutters, and the action is automatic, a weight (not seen in the figure) pulling the guard over immediately that the stuff has passed through. The guard can also be clamped in any position to expose only so much width of cutter as is actually required for planing narrow stuff.

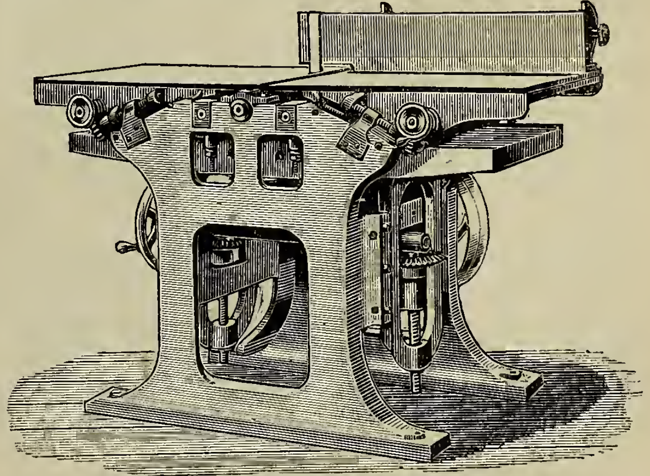


Fig. 10.—THOMAS ROBINSON & SONS, ROCHDALE.

I have thus rapidly enumerated the various machines which can be advantageously employed in pattern shops. They are not many, it is true, but any shop employing over half a dozen hands should have not only the lathes, but also the saws and planers. To keep the saws and the cutters in order should be made the duty of one man, who might employ the balance of his time in doing, if not all, at least a large proportion of the planing, sawing, and perhaps turning of the shop. The less division of labour in these things the better; one man will learn to do well and quickly by repetition what would be indifferently performed if it were everybody's business.

We see also that there is necessarily much pattern work to which machines lend little or no aid. All shaping of work of irregular outline, which in some jobs constitutes a large proportion of the total amount, must be done by hand; hence in certain shops, as those doing small cock and valve work and brass fittings generally, these machines would be of less relative value than in others doing large heavy work. But it is easy to decide in any case what tools will pay, and what not, and make selection accordingly. Of this, however, I am sure, that the results of the modern development of wood working machinery have not been utilised in our trade as much as they might have been.

J. H.

THE THERMO-DYNAMIC ANALYSIS OF THE GAS ENGINE.—III.

(Concluded from page 176.)

And now, I think, we have covered as much ground as we can advantageously discuss in the short time at our disposal. Let us therefore proceed with the deductions to be drawn from the arguments set forth.

1. In the first place, we may emphasise the great feature of the gas engine of the present day, namely, *compression*, for by it we get greater power in a less space, consequently less loss by radiation and conduction, less wear and tear, less cost of production; and should there be anything in this dissociation theory, compression is the antidote.

2. *Sustained pressure*, as in a steam engine, is a feature absolutely essential for many purposes—a feature we do not get in the gas engine of the day.

3. *Commotion* is another very important feature, and this again we do not get in the engine of the day, at any rate not in that degree necessary for rapid combustion.

4. Hot cylinders and no water jacket is about the greatest necessity of all, and seems to be the only hope of materially augmenting the efficiency of the present engine; for by cold cylinders it is admitted on all hands that fully 50 per cent of the developed energy is now lost.

How, then, are these very desirable features to be obtained? I will give you my own notions in answer to this question, and it will be for you to challenge any you may not think correct or feasible. I will take the fourth item first, because it is the most important one of all, and the one which really drew me thoroughly into the gas engine question. It is embodied in a patent I took out a year or two ago, but which for several reasons I did not think it prudent to attempt to develop immediately.

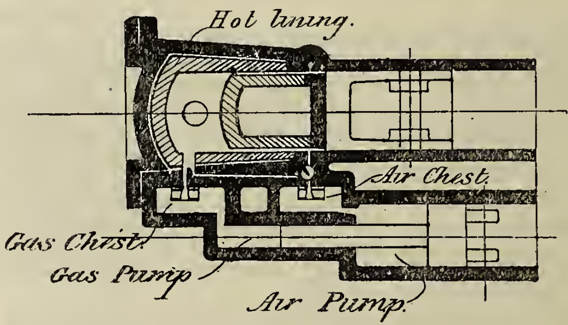
(Mr. Guthrie here gave a brief description of his patent.)

Taking the other propositions seriatim, we may take the first, namely, that of *compression*, as disposed of in the early part of my paper, and universally acknowledged to be beyond all question.

As to the second proposition, namely, that of *sustained pressure*, there is also little to question, for no one can deny the advantage, nay, even the necessity for certain work, such as winding and locomotion. It may be argued that the greatest number of foot pounds cannot be developed from a given quantity of fuel. No; but that is not so much the question as how can the foot pounds developed be utilised? And no one can question that with a hot cylinder without water jacketing more foot pound could be utilised than is now with water jacketing, and for sustained pressure these other features are not only almost a necessity, but in distinct unison, as will be seen.

And, again, in the matter of the third proposition, namely, that of *commotion* or *agitation*, it seems to me that this feature is only to be obtained by the last proposition of sustained pressure.

Will my proposed engine, then, answer to all these demands? I think so. In working this engine, which I hardly need say is of type 2, I propose to have a separate pump, and that pump to compress the air up to the working pressure of the engine, so that there may always be a pressure in the valve chest slightly superior to that of the cylinder, just as in an ordinary steam engine; with this pressure behind the valve we can secure the cool annular injection before referred to, and this gives us the means of doing away with that wasteful water jacket. We can secure a steady inflow of gas and air even while combustion is going on. And on these conditions, and these conditions only, a hot cylinder is admissible, for under the old system of admission of the whole charge first, and then ignition, a hot cylinder is out of the question, on account of the premature ignition it would cause. The process of admission, as I would propose it, is—as will be seen by referring to the illustration herewith, which shows an arrangement having separate gas and air valves—of the simple slide-valve type, with one portway only to each. The valve near the piston proper is the air valve, and supplies the cooling injection before described; but the air just after passing through this valve is divided into two streams, part for the primary purpose just mentioned, and part taken along a small passage or portway to the hot end of the cylinder, to mix with the gas and promote combustion. The valve near the hot end of the cylinder is the gas valve, the portway leading direct to the cylinder in such a way as to cause the jet of compressed gas to impinge upon the jet of cool air last mentioned. The process of one revolution would be this: the piston being right home, and with no more clearance than that of an ordinary steam engine, both valves would open, perhaps just a slight lead being given to the air valve so as to fill the cylinder clearance with the initial pressure before actual combustion commences. Then the instant the piston begins to move gas and air will enter together, and burn as they enter, without explosion. The combustion thus carried on will nearly expand the air and gas without any increase of pressure, for the instant that expansion takes place the inflow of fresh gas and air is checked, and only as the pressure tends to lower will fresh supplies flow in, burn, and keep up the pressure, so that the action is automatic. The ignition, of course, is spontaneous. The lining of the cylinder being hot, thus no igniting slide is necessary. It is true some igniting apparatus will be required for starting purposes until the cylinder becomes hot enough from working, but such an apparatus with such an engine as I am describing need be but of the simplest form. It is only necessary to form two very small bore holes leading into the ignition portway, the one to be supplied with gas and the other with air, under pressure, direct from the valve chests. Another small opening near these must also be provided through which the gas and air may be lighted, and, once lit up, will remain alight until turned off. One small double-way cock, or two small single-way cocks, then, is all the lighting apparatus required, and the same apparatus would be used for warming the cylinder before starting, if required.



This steady burning and expansion under uniform pressure would go on until the valves shut off the supplies, after which expansion under reducing pressure would continue to the end of the stroke, as in the steam engine. We can now easily see how a pretty brisk commotion or agitation will be maintained, for during the burning, under uniform pressure, a jet of flame is projected right across the cylinder, creating a constant disturbance; then, again, there is the flow of air from the annular space surrounding the plunger, and, like an Argand burner, streams out in a tubular form, and impinges against the side of the flame, assisting inflammation, not only by the agitation created, but also by the supply of fresh air for combination with any gas which may have escaped from the first flame unconsumed. The slide valves would be worked in exactly the same way and with exactly the same gear as an ordinary steam engine, with expansion and reversing gear as might be required. By this means the cut-off and power of the engine could be regulated to any degree required without cutting out whole strokes, and causing unsteadiness, as in nearly all the gas engines of the present day. The pumps would be automatically regulated in such a way as to cease working so soon as the working pressure was arrived at, relieving the engine of all unnecessary work and loss of energy.

The description I have just made is on the supposition that ordinary town's gas would be used; but this engine would be equally well adapted to the self-contained type (often called caloric) by attaching it to a gas generator, the details of which I need not go into now, as I have already taken up much time; suffice it to say that a generator can be made to contain enough fuel for a whole day's work without the necessity of re-charging, and an initial pressure can be produced in that generator to start the engine straight away, as easily as any steam engine, after steam has been got up in the boiler. I may further say that with such a generator, which need be no larger than an ordinary vertical boiler, a tram engine might run all day independent of all fresh supplies. It would show no steam (there being no water on board), it would emit no smoke, and would only put into the atmosphere one-quarter of the noxious vapours now sent from the present steam tram engines.

ELECTRIC RIFLES.

The latest invention in gunnery is the use of electricity in place of the percussion lock, the battery being situated in the stock of the rifle, and the spark furnished by means of a primary coil in a manner similar to the portable gaslighters, which, as is well known, when used with chloride of silver dry battery, will stand a use of 35,000 times without re-charging. It is claimed that this use of electricity as a denotator will make it possible to use the high explosives in rifles, and in this respect it may be claimed to form as great an improvement over the percussion lock as was the latter over the flint lock. This topic formed the subject of a paper by Captain S. A. Day, U.S.A., before the American Institute of New York City, in which he gave the most favourable opinion of the possibilities of this new method of firing rifles.—*Engineering.*

COMPOUND LOCOMOTIVES.

(CONTRIBUTED.)

I AM aware that the subject of compound locomotives has been previously discussed in other engineering papers by theoretical men, but have not seen any opinion given by a practical man, and I, having been engaged for upwards of 25 years in locomotive work, venture to give an opinion obtained from experience.

Any ordinary engineer will understand that a non-compound locomotive has two cylinders of the same diameter, say 18in.; consequently the steam is admitted (at boiler pressure) to the piston at each end of the cylinder, and there are of course four exhausts at each revolution, which I shall refer to further on.

The compound locomotive (Worsdell's system) has two cylinders also, but of different size, one 18in. diameter and the other 26in. diameter, which are placed in the same position, exactly between the frames, as the non-compound. The steam is admitted into the 18in. cylinder (at boiler pressure) first, and after doing work in this cylinder it exhausts into the steam-chest of the 26in. cylinder, and the reduced pressure acting on the large area of a 26in. piston will be about equal to the boiler pressure on the 18in. cylinder. Thus each piston will be doing about the same amount of work. There are two exhausts in this case against four in the non-compound to form the blast, and at a much lower pressure, consequently it is not so severe. The blast-pipe is about the same diameter in both cases, viz., 4¾in., and one result of the diminished blast is less consumption of fuel. I give herewith results of fuel consumption taken from the monthly return of February last, posted up in the running shed at Gateshead North-Eastern Railway, which cannot be disputed:

FEBRUARY.—Twenty-one engines, engaged running express trains to Edinboro,' York, and Leeds; average mileage, 3,811.

10 compounds:	11 non-compounds:
Average consumption, 29·6lb. per mile.	Average consumption, 34lb. per mile.

Difference in favour of compounds, 4·4lb. per mile.

Highest compound passenger:	Highest non-compound:
31lb. per mile.	38·6lb. per mile.

Difference in favour of compound, 7·6lb. per mile.

Compound goods engines working express trains to York and Leeds; average mileage, 3,760.

Compound goods engines:	Non-compound on same work:
Average consumption, 35·4lb. per mile.	Average consumption, 46lb. per mile.

Difference in favour of compound, 10·6lb. per mile.

This return shows what an immense saving of fuel to railway companies could be effected by the compound system, and chief-engineers of railway companies would do well to give them a trial, which can be done at very little cost on Worsdell's system, as it only entails the making of a pair of cylinders complete with valves, a few pipes, and Worsdell's patent starting valve.

In conclusion, I must say that I had my doubts about compounding locomotives four years ago, but now I am thoroughly convinced that they will beat the ordinary locomotive, both for economy and power, although they are only in their infancy, and feel sure in time that such waste of fuel as is now the case with non-compounds will not be allowed by directors of any railway company.

CORRESPONDENCE.

We do not hold ourselves responsible for the opinions of our Correspondents.

BRAKE TO PREVENT OVERWINDING.

To the Editor of "The Practical Engineer."

SIR,—As regards "Mining Engineer's" reply in your issue of the 6th, I am glad to find one who has the courage to acknowledge his mistake. This imputed misapprehension, however, was entirely due to his own misstatements. As to a powerful brake being essential, this I stated in my last; and if balancing be well known and valued, why is it not brought more into use than it really is, and thus raise the responsible office of a winding engineman to a sinecure, and equal to that of a mining engineer?—Yours faithfully, A PRACTICAL ENGINEER.

April 14, 1888.

TALLOW CUPS v. SIGHT-FEED LUBRICATORS.

To the Editor of "The Practical Engineer."

SIR,— I must again trouble you with a few remarks in answer to correspondents in your issue of April 13th. "Sight-Feed" says I have made some rather strong and misleading remarks in my letter of March 24th. I have read that letter over again carefully, but fail to see anything in it to rouse his ire. I do not wish to take up much of your valuable space in arguing whether his boiler pressure is higher or lower than mine, or whether the engine makes four or twelve revolutions after steam is shut off, or as to what condition I found the cylinders when they stopped suddenly with a groan; the latter can take place without seriously damaging the cylinders, and in the two former circumstances alter cases; but, as I stated in my previous letter, if lubricators are any use at all it is to reduce friction, thereby gaining power or less consumption of fuel, which I found to be the case after fixing a lubricator to each cylinder, costing thirty shillings each. A much larger size can be had for forty shillings.

"Sight-Feed" is quite right in saying that I agree with him that a constant feed is best, but not in the steam chest, as he thinks is the case with sight-feed lubricators. The best way to lubricate is in the cylinders, for there you have the greatest area to cover, and the valves will receive their fair share with the exhaust. This is my experience with the cylinder lubricators. They were regulated when first put on, over twelve months ago, just sufficient to empty the cup between meals, and have never required to be altered since. Any kind of oil or tallow, if clean, can be used in them. "Sight-Feed" and "Corliss Valve" appear to be satisfied with their sight-feed lubricators, and I do not think it would be possible to convince them that there is any other kind of lubricator made to beat them, for I have advised some of my friends, who have gone to an enormous expense in fitting their engines with sigh-feeds, to try these cylinder lubricators, but could not induce them because of the expense previously incurred, and my sole aim in writing my previous letter was to put such as "Eureka" on their guard against purchasing expensive lubricators, when, in my opinion, they could get others much cheaper and better; and I would still advise "Eureka" to try a couple of cylinder lubricators and sight-feed's before going the whole hog, and if he does not find a saving in fuel (I do not advocate the stinting of oil) or more power, why then, let him stick to his tallow cups. I still maintain that finding the cylinders and valves in good order is no criterion that they have been sufficiently lubricated, and "Sight-Feed" unconsciously bears me out when he says he has engines which have been at work thirty-six years, and that he has only had the sight-feeds on four years. They must have worked thirty-two years without them, and in good order, for all the lubricators in the world would not make the cylinders, valves, and valve faces like glass if they were cut previous to the sight-feeds being put on. I have only one word to say in reply to "Corliss Valve." In my opinion it is false economy to save oil at the expense of fuel by undue friction, and to give the name of the lubricator and maker, viz., "Cylinder Ball Lubricator," from Messrs. Bailey and Co., Salford.—Yours, &c.

April 14th. ECONOMY WITH EFFICIENCY.

THERMO-DYNAMIC ANALYSIS OF THE GAS ENGINE.

To the Editor of "The Practical Engineer."

Sir,—I observe in your journal a reprint of a paper on the above subject, read before the Manchester Association of Engineers, and should like to say a few words thereon. Two points only strike me for observation, but they are deemed by the author of the paper as of very high importance, as they much affect the question of gas engine efficiency. I have considerably studied the gas engine generally, and the two points in question very specifically, and I should like to help in the advancement of so useful an implement. The last point in order in the current number (April 13th) is agitation of the gases in the place or chamber of combustion, before and after ignition, in view of securing complete combustion. The author says: "Agitation after ignition seems to me a very important element in the future gas engine." Now, as your next number may considerably amplify his statement on this matter, I shall not assume that he may not have reasons beyond those yet presented for his stated views. I shall, therefore, now content myself with putting a simple question thereanent to him and to your readers, thus: Seeing that the purpose of agitation is thorough admixture for complete combustion of the gases, what possible reason can be shown why a similar agitation and admixture *just* before ignition should not be equally effective? And the practical point in view may be put thus: Is it, or is it not, probable that agitation before ignition may be the most readily attainable of the two? In my present opinion it is, and hence I may be deemed in order in thus putting the question. The second point may be suitably stated thus: Though not directly perhaps of a similar practical importance, it is manifest that the author is inclined to hold it very important, perhaps as much or more than "agitation after ignition." It relates to the dissociation of water, as water. Upon this the author enters pretty much at length. He says, "It is a matter of great surprise to me that the influence of pressure upon the point of dissociation has not been more fully recognised." And having adverted to the facts that water boils at 100° Fahr., under a pressure of about 2lb., at 212° atmospheric pressure, but requires 357° to boil it under ten atmospheres, he says: "If, then, pressure regulates the temperature of dissociation of water, as water, and at certain pressures and temperatures prevents the molecules from flying off from each other, have we not every reason for supposing that a similar condition of things obtains at the higher temperatures, regulating the temperature at which the molecules themselves split up into their elementary atoms? If this is so, then experiments in closed vessels are perfectly useless, for the pressure produced by ignition entirely counteracts the dissociation tendency." Now, while abstaining from any attempt to augment or lesson the importance of the question as affecting that of the possible efficiency of the gas engine under any specific conditions, I must say I admire the method of the lecturer in setting forth his positions. Now, "if" is a safe, and may be a useful means of setting forth an assumption, being itself the very sign of assumption—being *if, gif, give,* or *grant;* but it is, of course, always liable to the force of "the logic of facts," the "stubborn things that *winna ding.*" With your permission I shall suggest that the grant be withdrawn, and bring forward what should be deemed good and sufficient reasons, from the eminent authority on steam, C. Wye Williams, against the position that "pressure regulates the temperature" at which "dissociation of water, as water," takes place. And, as Mr. Williams[*] describes his simple process of proof of *his* position, in negation of that so naturally but only too readily taken as granted by the author and others, and so that any one can easily and safely repeat it, it seems plain that we must "go to proof" and let the facts speak for themselves, and I am inclined to think that the lecturer will find reliable basis for his conclusions as against the "dissociation of molecules" in gas engines, as this one recedes from his grasp. In your next, if allowed, I shall be glad to show forth the proof that water, as water, in an *open* vessel may be raised in temperature to 220° Fahr. without boiling, until the experimenter, with due caution for safety from the explosion which he can instantly command, places into the experiment the conditions under which water may give off its contained vapour, or steam, long after dissociation of its water, as water, had taken place. Believing the paper, as such, a most valuable one, and well worth favourable as well as questioning notice, I trust you will excuse my long letter.—Yours truly,

April 16th. Edward Hawks.

[*] "On heat in relation to water and steam," by Chas. Wye Williams.

BOILER REGISTRY AND INSPECTION BILL.

To the Editor of "The Practical Engineer."

Sir,—Will you please find room in your useful paper for a few remarks in reply to the correspondence that has been going on for some time in reference to the above bill? I certainly am in favour of yearly and compulsory inspection of boilers. Nevertheless, I must say that "Public Interest" has scarcely been met in a friendly spirit. One correspondent says, "I believe with our friend, Mr. A. Mosley, that the practical man should be before the theoretical." Well, sir, I will go much further, and say that practice combined with theory should go before either; and in reply to "W. M. H.," I would respectfully invite him to study for a short time the remarks of Mr. Wilson, late boiler inspector, on "Steam Boiler Explosions." He can get the book in any of our public libraries.

A second correspondent, "Engine Labourer," says: "I have been brought up all my lifetime amongst engines and boilers, and would like to be examined by the side of your correspondent if practical work, and not a severe examination in mathematics, were to be the test." Well, in looking over Reed's "Engineers' Handbook," I find that this dreaded examination comes to this: A second-class marine engineer must be 21 years of age; he must have at least served one year in the engine-room; he must be able to give a description of boilers, together with the use and management of the different valves, cocks, pipes, and connections; he must state the causes, effects, and remedies for incrustation and corrosion; he must be able to write and understand the first five rules of arithmetic and decimals. Now, I believe the above is the most important part of the great test examination, which we appear to be so much in dread of. I may mention, also, that certificates of marine engineers are of two descriptions—certificates of competency and certificates of service. It is easy to see that no practical man of service has suffered from the above. Again, "Engine Labourer" asks what would be the benefit of having compulsory examination of enginemen. He says "it would better a few lucky men, but injure a great many." I don't think so. Surely he would not have us to be always, as most of our fathers have been, working finger-and-thumb rule. No, I say, by all means compel our coming young men to make some advance, in order to protect the lives of our people more in the future than has been the case in the past. Again, "E. L." says, "take a large works where a great number of enginemen are employed, say at 30s. per week; the employers would look after a certificated man and set on any labourer about the place under him to take charge of engines and boilers." Now, this is the very thing that has been going on and is still going on. The practical, but uncertificated man, worth his £3 or £4 per week, is not very particular in setting on any labourer, not, indeed, at 30s. per week, but in most cases at 20s. per week, to fire the boiler, and stop, start, and oil the engines.—Yours, &c.,

April 13th. An Old Foreman and Steam-engine Driver.

To the Editor of "The Practical Engineer."

Sir,—Being a reader of your paper, and taking great interest in the above bill, and seeing so many (so-called practical engineers) who seem afraid of being examined as to their fitness, I cannot but feel surprised, for they must imagine they see the lion when it is only the lion's skin. I for one would welcome the bill, as I think it would improve the condition of the working engineer. Some of your correspondents ask if all those who failed to pass would be discharged. Were all the old marine engineers discharged when their bill passed? I think not. A certificate of service would meet the fears of these men. Others say that a number of small firms and holders of small boilers would be compelled to give up. I would ask how many of the small boilers of the out-of-the-way places have blown up? I think they figure too high. Now, if the bill only saved a few cases, it would be worth while to have it passed. Others think we do not need the bill because the insurance companies prevent explosions; I do not doubt but what they do good, but too much faith should not be put in them, for I believe, with "Governor," that they only take the boilers that are safe. The boilers we had at our firm were old, and the company soon began to cut the pressure down. The inspectors only go inside the boiler once in twelve months, and once or twice they come just to look round. Now any practical man knows that many things may happen in a twelvemonth. I will give one or two cases. A few weeks after the inspector had been through our boilers, and reported all working well, I noticed a leakage over the furnace at the front end of one of them, so I went in and examined it, and found the angle iron broke. I told the masters, and advised them to have it repaired; and when the angle iron came out we could put a penny piece through for about six inches long. Now, this was done without the knowledge of the insurance companies, and it is not the only case, for I have had others done, and engineers who I know have told me about having put new boiler fronts in without the insurance company's knowledge. Now, sir, taking all things into consideration, I think the best thing is that every engineer who has charge should be able to say what wants doing, and when, and to do this he must hold something to show that he has authority for what he is saying, and that authority would be a certificate.—Yours, &c.,

Oldham, April 14th, 1888. Fair Play.

The Patent Laws.—Sir Henry Roscoe last week asked the President of the Board of Trade whether his attention had been drawn to memorials referring to recent decisions of the Court of Appeal in cases of patent law presented to the Board of Trade by the Bolton and Oldham Chambers of Commerce, and by Messrs. Crosses and Winkworth, Limited, and whether he would state if it was the intention of the Government shortly to take action to amend existing patent laws in such manner as to protect innocent purchasers and users of patented articles and apparatus who had acted in good faith from vexatious and costly litigation, and to confer upon parties to actions for infringement of patents the right of trial by judge and jury in the ordinary manner. Sir M. Hicks-Beach said it was the intention of the Government shortly to introduce a bill amending in some minor points the Patent Acts, when the memorials would receive consideration.

QUERIES AND REPLIES.

Stamping Machine.—Can any reader inform me where the best machines are to be procured for general tinplate workers' stamping, or, as the French call it, embouté, all kinds of tin articles?—J. H.

Answer.—Write to Messrs. Tayler and Challen, engineers, Birmingham. They will probably be able to suit your requirements.—A. W., Villa Cross.

Designing Engine Cylinder.—I intend making a steam engine, 3in. bore, 6in. stroke. Would some one kindly show me how to find the size of ports, and thickness of material, cylinder, and steam chest (ordinary cast iron); also length of connecting rod?—Bolt.

Answer.—

Thickness of body		$\frac{7}{16}$in.
Thickness of flanges		$\frac{9}{16}$in.
Thickness of body of steam chest		$\frac{3}{8}$in.
Thickness of steam chest flanges		$\frac{1}{2}$in.
Depth of piston		$\frac{3}{4}$in.
Diameter of piston rod		$\frac{1}{2}$in.
Length of steam port		2in.
Width of steam port		$\frac{1}{4}$in.
Width of exhaust		$\frac{3}{8}$in.
Length of connecting rod	centres	12in.
Diameter of connecting rod at end	bare	$\frac{19}{32}$in.
Centre	full	$\frac{21}{32}$in.

"Bolt" will probably find what he requires in the above.—A. W., Villa Cross.

Answer.—Area of ports for engines of average speeds = $\frac{1}{11}$ or $\frac{1}{12}$ of the piston's area, cylinder diameter = 3in., and area = 7·3662; $\therefore \frac{7{\cdot}3662}{12} = {\cdot}6138$ = port area. Suppose you make the ports $\frac{3}{8}$in. broad, so as not to have your steam chest longer than the cylinder. The length of ports will then be about $1\frac{5}{8}$in. For $\frac{3}{8}$in. = ·375in., and $\frac{{\cdot}6138}{{\cdot}375} = 1{\cdot}63$in., or fully $1\frac{5}{8}$in., and with a steam port $\frac{3}{8}$in. × $1\frac{5}{8}$in. you will require an exhaust either $\frac{5}{8}$in. × $1\frac{5}{8}$in. or $\frac{1}{2}$in. × $1\frac{5}{8}$in., and the bridges either $\frac{5}{16}$in. or $\frac{3}{8}$in. broad. The metal in cylinder and casing should be about $\frac{1}{4}$in. thick, but the thickness of steam cylinders cannot be deduced from any fixed rule which would be practical in all cases; for instance, a cylinder 6in. diameter should be at least $\frac{5}{8}$in. thick, whereas one 24in. diameter should be about $1\frac{1}{2}$in., the former $\frac{1}{9}$ of diameter, and the latter is $\frac{1}{16}$ of the diameter. The connecting rod is generally about 2 or $2\frac{1}{2}$ times the length of the stroke; the longer you make it the less will be the pressure on your guide faces.—D. Arnot.

Regulating Engines.—Will some of your readers kindly give me their experience as to the best arrangement for regulating an engine with constantly varying and extreme loads; *i.e.*, whether to apply sensitive governor to throttle or to variable cut-off gear. The particular engine I have in view has slide valve with cut-off plates on back, and boiler pressure of 70lb.—X. Y. Z.

Answer.—I should advise "X. Y. Z." to dispense with cut-off plates altogether, and apply to main valves Powell's automatic expansion gear. The saving in steam will be about 20 per cent over cut-off plates, and the governing of the engine will be perfect.—R. B.

Answer.—The only plan of regulating an engine with the varying load described is to adopt a compensating apparatus of the sort described on page 174 of this journal. No unassisted governor, however sensitive, can give even turning in such circumstances.—M.

Answer.—Variable cut-off gear would suit you best. Throttle valves could not be made near as sensitive as expansion gear.—A. W., Villa Cross.

Colliery Engines.—(1) A colliery has an output of 1,000 tons of coal, raised from a depth of 120 fathoms in 10 hours. Give h.p. of engines, diameter of cylinders, diameter of drums, pulleys, steel wire rope, number and size and h.p. of boilers, to do the work. (2) There are 800 gallons of water per minute in the above pit. Give h.p. of engine, diameter of cylinders, diameter of pumps, length of stroke, size of pump rods, number and size and h.p. of boilers, allowing boiler pressure 40lb. per square inch in both questions, the pumps to do the work in 10 hours per day.—J. W.

Answer.—In answer to "J. W." on the above subject, we will assume, say, three tons of coal to be raised from the pit at one draught in half a minute, while one minute is occupied in removing the loaded wagons from and putting the empty ones into the cage; thus with two ropes in the pit three tons of coal may be landed per $1\frac{1}{2}$ minute, or at the rate of two tons per minute, which, if continued for ten hours, would amount to 1,200 tons. Assuming the 40lb. pressure of steam spoken of to be only that shown by the gauge above that of the atmosphere, or the absolute pressure to be 55lb., and that two cylinders, each 31in. diameter, steam admitted throughout the stroke, with piston stroke of 5ft. to be used, each piston being connected with a crank or winding drum shaft, the two cranks being at right angles to each other, the largest diameter of each winding drum being 14ft. and the smallest 12ft. respectively, also the pulleys over the shaft to be not less than 12ft. diameter, grooved for a steel wire rope $3\frac{3}{4}$in. circumference, the engines will require a steam supply equal to that of four Lancashire boilers, say 7ft. diameter by 28ft. long each. Or if the steam, in winding, be used expansively to its full extent, the cylinders acting on each crank may be compounded in tandem form, each h.p. cylinder being 26in. diameter, and l.p. 50in. diameter, each piston-stroke being 5ft., steam being cut off in h.p. cylinders at $\frac{5}{8}$ of the stroke, all the other arrangements being as above, excepting only two such boilers as above being now requisite to do the work. The steam is admitted to each h.p. piston past the half stroke, so that at any point of the stroke the engines may be stopped or reversed with the utmost facility, an essential requisite in a winding engine. Either of these engines has sufficient power to bring up a load of $3\frac{1}{2}$ to 4 tons per lift, if required. Regarding the power of the pumping engine, which in addition to the influx water has the clack, gland, bucket, and pipe leakages and losses to make good, as well as overcome friction, inertia, &c., if we suppose it, for simplicity of considering, to be a condensing beam engine, with the pump-rods attached to the end of the engine beam and the full steam pressure admitted to the piston throughout the stroke, we find the required diameter of the cylinder to be 112in., with length of stroke, say $10\frac{1}{2}$ft., and the piston making 5 strokes per minute, the pump barrel required being 35in. diameter, the weight of the water column being no less than 135 tons, with an internal pressure on the pipes at the bottom of 312lb. per square inch. To reduce the above weight and pressure the column should be divided into at the least 3 lifts of 40 fathoms each, giving a weight of column of about 45 tons, and a pressure of about 104lb. per square inch. The three lengths of pump-rods I would suggest to be of wrought iron 9 square inches in section, and so arranged that balancing them by counter weights, as is usually done, is unnecessary, inasmuch as their weight in descent forces up a column of water of equal weight, and so relieves the load on the up-stroke to that extent. The large amount of work the engine has to perform with its limited steam pressure prevents the application of the principle of expansion, so that under these circumstances eight steam boilers of such size and power as named above would be requisite for the work of pumping. In all cases as the above, where such massive steam machinery is required for mine pumping, the writer would suggest a different arrangement, and so dispensing with it, or with its usual substitute, viz., heavy wheels and gearing. A very considerable increase of steam pressure in the boilers would be a very considerable advantage in lessening the dimensions and cost of working this engine, or one of any other form that may be devised instead of this. Limited space prevents further details here, of which perhaps I have already occupied too much.—W. A.

Steel Plates.—Will some reader kindly give me a list of lengths and widths of iron and steel plates kept in stock by most merchants. What I want is to be able to design tanks, boilers, &c., without having to get them cut, as this increases the labour, and does not add anything to the strength.—H. L. C.

Safe Load on Bolts, &c.—Will any reader give me (1) a table or formula for the safe load on bolts, from $\frac{1}{4}$in. to 2in. inclusive; (2) a table for the safe load on ordinary gas tubes, when used say for deep well pump rods; (3) a simple formula for working out the power of a compound pumping engine (direct acting), having only the steam pressure at h.p. cylinder given, no indicator diagrams.—J. L.

Sight-feed Lubricator.—I have now in my charge a sight-feed lubricator connected to the main steam pipe, which, instead of sending the lubricant in the cylinder drop by drop, as it ought to do, breaks the lubricant in *bits*, and fills up in the glass. I have tried several ways to ascertain the cause of this, but have repeatedly failed.—J. P.

Splicing Ropes.—Will any reader kindly inform me what are the most modern methods of splicing ropes for working on pulleys, and do those methods labour under any disadvantages?—R. L. F.

Drag Links of Paddle Engines.—A dimension sketch and description would be of value to the undersigned; also please say whether the link should not lie freely on the pins, like the coupling rod of a locomotive, instead of having brasses so tightened up as to make it immovable, and oblige—Shiny Boots.

Twiner Spindles.—How many twiner mule spindles are reckoned to the horse power?—Inquirer.

Illuminating Paint.—I should be glad to have the address of a maker of illuminating paint.—S. C.

Electro-plating.—Could any reader kindly inform me how I best could re-electro.plate a tricycle? The cheapest and simplest style will oblige.—Club Tandem.

Twist Drills.—Can any reader give me any information regarding these? Are they milled? If so, how? Is cutter arranged to get the under-cut? How are they ground for clearance? Could they be cut in a lathe?—A. R.

TO CORRESPONDENTS.

W. Le P. W.—The address you require is Wm. Pickard, 33, Leaver Street, Coldhurst, Oldham.

Apprentice.—The area of the cylinder is 113·1 square inches, and this, multiplied by the pressure, will give the weight that must be put on the piston. Thus, for 200lb. pressure we must have 113·1 × 200 = 22,620lb. weight, or just a little over 10 tons. For 300lb pressure we shall want just over 15 tons, and for 500lb. just over 25 tons. The thicknesses of material would be determined by questions of casting rather than mere strength; a thickness of $\frac{5}{8}$in. would be ample for the highest pressure.

Public Interest.—Will "Public Interest" forward his address to W. M., 166, Rhodeswell Road, Limehouse, London, E.?

J. D.—The wheel was given as 30ft. diameter, or say $94\frac{1}{4}$ft. circumference; so that the ropes will travel at a velocity equal to $94\frac{1}{4} \times 60$ft. per minute = 5,655ft., or upwards of a mile a minute.

A Beginner.—The atmospheric pressure must not be added.

Apprentice.—Consult Seaton's book on Marine Engineering for all the matters mentioned in your letter.

J. K.—The price varies very much according to make and get up, but a good instrument should be obtained for about £8.

Turkish Bath.—We have no information on the subject.

MISCELLANEA.

Pintsch's Oil-gas.—There are nearly twenty-five thousand railway carriages now lighted, chiefly on the Continent, on Pintsch's oil-gas system.

The Wheel and Van Tax.—Mr. Goschen, it is said, is contemplating another modification of this tax, which will, it is thought, relieve smaller tradesmen.

Voided Patents.—Nearly 400 patents taken out in the first week of 1884, which was the first year under the new act, have become void through non-payment of the fourth year's fee.

Schools for Women.—Sir Donald Smith has given $25,000 to the Royal Victoria College at Montreal, for establishing preparatory schools for women in Manitoba and the North-West.

Train Lighting.—Experiments are now being made with the view of lighting express trains on the Great Northern line by electricity. Four trains running in the metropolitan district are already so lit.

Pope's Gaslight System.—The Lancashire and Yorkshire Railway Company is fitting 941 passenger coaches with Pope's gaslight, and has ordered two sets of gas plant complete, to produce the requisite gas.

Red Snow.—The curious phenomenon of "red snow" was observed the other day in the Gail Valley, Tyrol. It appears the size of the hand on the white surface of the snow, and when left to melt on a piece of paper there remains a brick-coloured sediment.

Light Reciprocating Parts.—In all quick-running engines the reciprocating parts should be made as light as possible. Engines have been known to persist in "knocking" until the pistons were replaced by others about half the weight.

German Steel Contract.—The Cockerill Company of Seraing, Belgium, has again successfully competed for a German contract. The company's tender for the supply of 2,000 tons of steel rails for the north of Germany, delivered at Hamburgh, has been accepted.

Extension of Works.—The Junction Ironworks, Newton Heath, recently owned by the Junction Ironworks Company, Limited, have been purchased from the liquidator by Mr. Samuel Brooks, of the Union Ironworks, West Gorton, who intends to carry them on as a branch establishment. The works will afford employment to about 500 persons.

Speed of Band Saws.—In a French journal the engineer, M. Laurent, gives an account of his experience of seven years in the shops of the Compagniedu Midi with band saws for cutting metals. He gives as the proper speed for such saws 66m. per minute for wrought iron, 45m. for cast iron and steel, and 85m. for bronze and allied alloys. This is equivalent to 216, 147, and 279 feet per minute respectively.

Technical Instruction.—A conference on technical instruction for tin, iron, and zinc-plate workers, coppersmiths, and others (the sixth of the series), was held at the Finsbury Technical College, Leonard Street, City Road, E.C., on Wednesday, at 7-30 p.m. The discussion was opened by Mr. C. T. Millis, M.Inst.M.E., superintendent of the trade classes of the college. Hodgson Pratt, Esq. occupied the chair.

Submarine Boat.—Tests are being made in Germany with what is stated to be a new type of submarine torpedo boat, which can dive with safety to a depth of 95ft. below the surface of the water, immersion being effected by means of two vertical screws absorbing 6 horse-power. The boat, which is 114ft. in length, provides accommodation for three persons, and is fitted with two torpedo tubes and a machine gun.

Liquid Fuel for Steelworks.—The Union Steel Company, of Chicago, is putting into the steelworks a liquid-fuel plant to use crude petroleum. Two 1,000-barrel tanks are being erected, into which the oil will be pumped from cars, and from which it will afterwards be pumped as required into smaller tanks for use at the respective batteries of boilers. The officers of the company hope to be able to use it not only under boilers, but to substitute it for gas in the soaking pits and re-heating furnaces.

Dublin and the Electric Light.—The Corporation of the City of Dublin is applying, under the Electric Lighting Act, to the Board of Trade for authority to supply the city with electric light. It asks for liberty for this purpose "to open and break up streets and bridges, to alter the position of gas and water mains, pipes and wires, sewers and drains, under the same; to acquire lands, to appropriate lands, to construct such works, acquire such licenses, to enter into such contract, and to do all such acts and things as may be necessary and incidental to such supply." The proposed area of supply is the city without limitation of any district.

Electrical Welding.—Prof. A. E. Dolbear writes to the *American Engineering Record* as follows: "I have had made nearly a hundred tests of the tensile strength of electrically-welded bars of iron, steel, and other metals. The results were of such a character that I can state positively that with Thomson's welding process it is possible to weld both wrought iron and steel so that the weld is as strong as the same cross-section in another part of the bar. I had a number of bars welded by an expert blacksmith and a number of similar ones by the electrical process for comparison, with the result that the electrically-welded bars were much stronger than those welded by the ordinary process. The bars were of various sizes, up to an inch and a half for iron, and three-fourths of an inch octagon steel."—*Electrical Review.*

The Institution of Mechanical Engineers.—The ensuing ordinary general meeting of this institution will be held on Thursday evening, the 3rd of May, and Friday afternoon, the 4th of May, at 25, Great George Street, Westminster. The chair will be taken by the president, Edward H. Carbutt, Esq., at half-past seven p.m. on Thursday evening, and half-past two p.m. on Friday afternoon. The following papers will be read and discussed, as far as time permits: "Third Report of the Research Committee on Friction: Experiments on the Friction of a Collar Bearing;" "Description of the Emery Testing Machine," by Mr. Henry R. Towne, of Stamford, Connecticut, U.S.A.; "Supplementary Paper on the Use of Petroleum Refuse as Fuel in Locomotive Engines," by Mr. Thomas Urquhart, locomotive superintendent, Grazi and Tsaritsin Railway, South East Russia. The anniversary dinner will take place on Friday evening, the 4th of May.

H.M.S. Victoria.—On Saturday week, the new warship Victoria was slowly towed from Elswick, down the river Tyne, and out to sea, by seven steam-tugs. The river banks were lined with people on both sides at all the more important centres of population. The voyage was accomplished without any hitch. At the Swing Bridge there were very few inches to spare in the width of the opening, and at one time fenders had to be used to soften down a slight collision. In crossing the bar, thanks to the work of the Tyne Commissioners, there was plenty of depth of water, notwithstanding the heavy draught of the enormous vessel. On reaching the open sea several hours elapsed while the compasses were being adjusted, and then the vessel, propelled by her own engines, was quickly out of sight. On Monday she arrived at Sheerness, and was taken in charge by the Medway Steam Reserve authorities. Some time will elapse before she is fit for active service, but no effort will be spared to finish her as soon as possible. Her cost to the country will be over £800,000. If she had been made at any of the Government dockyards instead of by contract, it is probable she would have cost a great deal more.—*Engineer.*

SELECTED PATENTS.

APPLICATIONS FOR LETTERS PATENT.

April 6th.

5105 Governing the Speed of Engines, R. H. Twigg, Westminster, and J. H. Turner, Wandsworth.
5108 Valves, W. Hartcliffe and W. H. Malkin, Manchester.
5109 Water Gauges, W. Hartcliffe and W. H. Malkin, Manchester.
5116 Propeller Blades, J. Willis and Co., Sheffield.
5131 A Storage Motor, C. A. Randall, Brompton.
5148 Moulding Tubes, R. Mannesmann and M. Mannesmann, London.
5150 Brakes, B. J. B. Mills, Middlesex. (Monsieur and Madame Guetton-Gangon and Jules des Georges, France.)
5151 Cleaners for Boilers, J. C. Fell, London. (J. Bower, Norway.)
5152 Flanging Machine, E. A. S. Templeton and W. Schischkar, Loudon.
5153 Boring Machine, E. A. S. Templeton and W. Schischkar, London.

April 7th.

5160 A Rotary Engine, S. J. Hamblin, Newbury.
5167 Reciprocating Fluid Engine, T. Thorp, Lancashire.
5171 Miners' Lamps, J. T. Key, Sheffield.
5174 Runner, A. S. E. Bey, Turkey.
5188 Governor for Engines, F. W. Dodd, London.
5191 Storage Batteries, H. Edmunds, Streatham.
5206 Motive Power Engines, O. J. Ellis, London.
5209 Steam Engines, S. S. Welch, London.

April 9th.

5218 Disengaging Lever for Starting Steam Engines, H. Shaw, Birmingham.
5220 Indicating the Flow of Water in Pipes, C. Stout, Cheshire.
5223 Purifying Water for Boilers, G. W. Allen and H. J. A. Bowers, Manchester.
5228 Heating Feed-water in Boilers, A. MacLaine, Antrim.
5231 Combined Motor, F. N. Mackay, Liverpool.
5235 Taps, S. H. Fletcher, Birmingham.
5240 Protecting Boiler Tubes, W. Hague, London.—[Complete Specification.]
5249 Self-sustaining Hoists, W. R. Hay and W. A. Grocock, London.
5251 Moulds for Casting Metal, H. J. Smith, Glasgow.
5263 Steam Boilers, G. Woolnough, London.

April 10th.

5290 Couplings, M. Raymond and F. Raymond, Blackheath.
5294 Valves, E. Partington, Manchester.
5295 Valves, H. Aitken, Glasgow.
5296 Generating Steam, H. Aitken, Glasgow.
5300 Propeller, W. H. Fry and T. Fry, Tynemouth.
5310 Multiple Cylinder Motors, W. P. Thompson, Liverpool. (E. B. Benham, United States.)—[Complete Specification.]
5336 Weighing Machines, J. Q. Preble, London.—[Complete Specification.]
5342 Heating Feed-water of Boilers, J. Kirkaldy, Middlesex.
5348 Wind Engines, J. W. Titt, London.

April 11th.

5357 Steam Motors, J. E. Wallis and F. A. Wallis, Hampshire.
5362 Arc Lamps, J. H. Holmes, Newcastle-on-Tyne.—[Complete Specification.]
5374 Ball Valves, C. E. P. Gabriel, trading as Gabriel and Co., Birmingham.—[Complete Specification.]
5377 Lubricators, J. M. Croom, Edinburgh.
5379 Steam Boilers, G. Rowland, London.
5381 Rudders, G. T. Haigh and J. Green, Liverpool.
5388 Hose Couplings, F. W. Klever and C. A. G. Storz, London.
5393 Galvanic Batteries, A. F. St. George and C. R. Bonne, London.
5395 Carding Engines, J. W. Shepherd, W. Ayrton, and T. S. Whitworth, Manchester.
5402 Propellers, B. J. B. Mills, Middlesex. (L. Bidauld, France.)—[Complete Specification.]
5405 Wrench, A. G. Boutcher, Middlesex.
5407 Means for Propelling Boats, J. Tarrillion, London.
5412 Hoisting Machinery, J. Stannah and G. Pinker, London.

April 12th.

5431 Slide Valves, Henry de Garrs, Sheffield.
5437 Lubricators, C. Schaeffer and G. Oehlmann.—[Complete Specification.]
5441 Hoists, W. Workman, London.
5442 Fire-bars for Steam Boilers, J. Battersby, London.
5443 Printing Machines, F. M. Mole, Birmingham.
5448 Slide Valves of Steam Pumps, Tangyes (Limited) and J. N. Floyd, Middlesex.
5463 Construction of Steam Boilers, T. Quinlivan, London.
5465 Gas Cocks, E. Arthur de Pass, London.
5468 Rotary Engines, J. P. H. Gastrell, London.
5469 Railway Coupling, J. Brandy, London.—[Complete Specification.]
5473 Combined Railway Buffer and Coupling, J. Brown, T. H. Jones, and J. C. Oakman, London.

NOTICE TO NEWSAGENTS AND SUBSCRIBERS.

Numerous complaints having been made to us by Subscribers of the difficulty they experience in obtaining copies of the *Practical Engineer* in certain districts, we have to state that the Journal can be obtained by any Newsagent through the ordinary trade channels, and no difficulty should therefore exist in obtaining copies by order of any Newsagent.

For the information of the trade, we may state that copies can be obtained from either of our Offices in London or Manchester, or from any of the following wholesale houses.

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&c., &c., &c.

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EDITORIAL NOTICES.

All communications for the Editor of this Journal should be addressed to 6, Victoria Station Approach, Manchester.

Communications intended for insertion in the current week's issue should reach us not later than Tuesday Evening.

We cannot undertake to return rejected manuscripts or drawings unless accompanied by a stamped and directed envelope.

Contributors are requested to write on one side only of the paper. Sketches should be sent on separate sheets.

TO ADVERTISERS.

Advertisements intended for insertion in the current issue should reach us on Wednesday morning at the latest.

Important Notice to Newsagents and Subscribers.

Our Publishing Offices in London are now at 11, PATERNOSTER BUILDINGS, E.C., where the Trade will in future be supplied.

Simultaneously with the above change, our PUBLISHING OFFICES in MANCHESTER have been REMOVED from Grosvenor Chambers, Deansgate, to more commodious and convenient premises at 6, VICTORIA STATION APPROACH, where all communications intended for the Manager or Editor should, in future, be addressed.

THE
PRACTICAL ENGINEER.

APRIL 27TH, 1888.

THE STEAM ENGINES AND BOILERS BILL.

As briefly intimated in our last issue, the fate of the bill for examining and granting certificates to persons in charge of steam engines and boilers was definitely settled, at least for the present, on the evening of Tuesday week, when the motion for second reading was defeated by a majority of 51—96 members voting in favour of the bill and 147 voting against it. So much interest, however, has been excited by this bill amongst a certain section of our readers, as evidenced by the correspondence which has taken place in our columns, that we have thought it advisable to briefly glance at the case for and against the bill, which was very fully discussed in the House. A strong point made by the promoters of the bill is that, since marine engineers have been required to pass an examination, a great saving in life and property has been the result, boiler explosions having almost completely disappeared from the calamities occurring at sea; and it is urged that if those in charge of engines and boilers in our large towns were compelled to undergo a similar examination, at least equal advantage would result on land. In order to disarm opposition on the part of those already employed in looking after engines and boilers, and so that these would experience as little hardship as possible, the bill provided that all who had been in charge of either an engine or a boiler for a period of two years or more should be recognised as competent without examination. Thus it will be seen that in this respect the bill is the same in principle as the Architects' Registration Bill, to which we have already referred, and one effect would be to create a monopoly, or a kind of close corporation, in favour of those already in this employment, by preventing others from entering the trade upon the same terms as those at present holding situations. It has consequently received, as might be expected, the warm support of enginemen and boiler attendants, who, at their various club meetings, have passed unanimous resolutions in favour of Mr. Broadhurst's bill.

Ostensibly the main object of the bill is to reduce the annual number of boiler explosions, but in order to show that this object will be accomplished it requires to be proved that such explosions arise from the ignorance or incompetence of those who have had the care of the boilers which have failed. Unfortunately, the statistics of boiler explosions do very little to prove this, and a strong point was made of this by the President of the Board of Trade (Sir Michael Hicks-Beach), who pointed out that of 57 explosions which occurred in the year 1885-6, not one would have been avoided by the bill, which would do nothing to prevent deterioration, corrosion, or defectiveness of the safety valves, which caused 32 explosions, or remedy defective design or construction, which was responsible for 16 accidents. Ignorance or carelessness, to which six explosions were attributed, was the only cause which could possibly be considered to be dealt with by the bill, and considering all the circumstances, and that the bill would seriously and unnecessarily interfere with agriculture and the smaller trades, he expressed himself as bound, on the part of the Government, to oppose the second reading. Mr. Broadhurst, in supporting the bill, referred to several explosions of traction engines, one of which occurred at Maidstone, and another at Rochester. All these explosions, if we are not mistaken, arose through the safety valves, which were loaded by a spring balance, having been screwed fast down and rendered inoperative. In one instance, however, at Chesterfield, the pressure gauge was also seriously defective, and although these explosions might have been brought about by ignorance, it is quite possible they were due to something worse. The bill might prevent anyone taking charge of a boiler who was not aware of the danger of overloading a safety valve, but it could not provide against skilled malice, and in most of the cases above referred to the explosions could not have occurred had the safety valves been ferruled, as they ought to have been, so that they could not have been screwed fast down.

Proper supervision and inspection would have prevented both these explosions, and we think Mr. Jacob Bright was quite right in saying that if we are to have legislation at all, in order to give greater security to life and property, it ought to be in the direction of compulsory inspection of boilers. So few explosions happen from the ignorance or carelessness of the men in charge of boilers—to their credit be it said—and many of those which do happen would be prevented if only the negligent and parsimonious owners were compelled to register their boilers and place them under competent supervision (not necessarily Governmental), as the better class of steam users do voluntarily, that we feel quite sure a simple Boiler Registration and Inspection Bill, not interfering unduly or too harshly with the liberty and the business of boiler owners, but making inspection universal, would do far more towards preventing boiler explosions altogether, and with less hardship towards any particular class of persons, than an act rendering certain persons privileged by right of prescription could possibly do. There can be no doubt that widespread hardship would be experienced, particularly in the case of steam users in a small way, by the passing of an act such as proposed, as in an emergency it might often be extremely difficult to find a man with a certificate to attend to a boiler, where, for instance, only one man was employed to do many small offices. The act would also require extending to women, as there are numbers of institutions where there are female boiler attendants, the writer having met with many such in convents, training schools, workhouses, &c., throughout Ireland. The House therefore, on the whole, we consider has taken a common-sense view of the matter, and the result will, we think, be such as will commend itself both to the general public and to those who have had most experience in investigating the causes of boiler explosions. Such occurrences are rarely, if ever, in the true sense of the word, "accidental," and it is quite possible by due supervision and proper equipment—by seeing, in the first instance, that boilers are not capable of being loaded to a pressure beyond what they are suitable for, and afterwards periodically noting any indications of deterioration, &c.—to put it almost out of the power of ignorance even to bring about these dire calamities.

THE GLASGOW EXHIBITION.

This Exhibition was opened for the Press view on Saturday last, and revealed a degree of forwardness, as regards the exhibits, not usually found in large exhibitions of this kind. The structure is very imposing in appearance, and, as regards mere size, it must be conceded the palm over all the exhibitions held in this country since 1862. The building itself will cover 14 acres and the grounds 66 acres, as compared with 14 and 45 respectively of the Manchester Exhibition last year. The great nave is over 1,000 feet long, and a large proportion of the space in it is devoted to the shipbuilding exhibits, though there is no attempt to show the progress of shipbuilding from the earliest times, such as might have been expected. The machinery section should prove very interesting, combining as it does the industries of Manchester, Birmingham, Newcastle, Liverpool, and other centres. A regrettable circumstance is the entire absence of locomotives, which is all the more surprising seeing that Glasgow is one of the largest centres of this industry in the kingdom. The Exhibition will be opened by the Prince and Princess of Wales on the 8th May.

LITERATURE.

Steam and Steam Engines. By Andrew Jamieson. 400pp.; price 7s. 6d. London: Charles Griffin and Co.

Engineering students, whether going in for the Science and Art or the City and Guilds of London Institute, or other examination in steam and the steam engine, will find in the volume before us a most useful and clear help. The author has written his pages in a simple style, and has kept them free from mathematics wherever possible, so that the information given is in a very readable form, and will be appreciated by all students. The book is essentially one for students, and hence matters of practical detail and dimensions do not find a place in it, but are very properly left to other more pretentious volumes. A very clear and correct record is given of the steam engine—land, marine, and locomotive—which will enable the reader to trace very readily the various stages of progress and improvements effected in the various styles, from the pumping engines of Savery and Newcomen to the present Corliss engine, and from the engine of the "Comet" to the modern triple expansion engine, with its splendid record of economy and efficiency.

After the historical chapters come others on thermometry, calorimetry, heat—latent and sensible—evaporation, laws of pressure and volume of gases, &c., usually found in text-books of this character. Then follows a chapter on the distribution of steam in the cylinder, in which the meaning and various points connected with lap and lead are very clearly explained. An Appendix to Chapter XIV. contains some empirical formulæ for the pressure, density, and volume of steam, constructed by James Brownlee, of Glasgow, which are interesting inasmuch as they have not been published before, and further because it was on this gentleman's experiments that Prof. Rankin based the constants in many of his well-known formulæ for these matters. A chapter on indicators follows, which will be very useful to the student, and so will the next two chapters on horse-power, and the methods of determining it by brakes and other means, and the effect of inertia of moving parts. The author then describes particularly two or three styles of land engines as made by Messrs. Marshall, Gainsborough, and afterwards we come to the marine section of the book, in which the various types of engines are briefly noticed. A chapter is devoted to compound engines, in which the engines of the s.s. Rignould are very fully described, and illustrated freely by sectional drawings both of engines and boilers. A specification of these engines, printed in full, will give the reader a very good idea of the detail of the engines and of the kind of thing makers are expected to work up to. Triple and quadruple expansion engines, the latest development in marine engines, are also noticed and illustrated by some capital engravings. The following chapters enter more into the detail of the working parts, such as cylinders, valves, pistons, pumps, link motion, connecting rods, cranes, bearings, &c., and all these are very freely illustrated; in fact, throughout the book the illustrations are exceedingly full, and make a very attractive and useful feature.

The chapter on land boilers contains a very meagre working sketch of a Lancashire boiler, and a rather better one of a water-tube boiler. The latter can hardly be said to have found much favour in this country as yet, though it is very popular in America. A chapter on riveting, &c., brings this portion of the book to a fitting close.

The locomotive section contains a sectional drawing of a four-wheel coupled bogie express engine, with extracts from a specification for the same, as well as notes on Joy's valve gear, the injector, &c. We can heartily recommend the book as being about the best extant for the use of students.

The Liverpool Exhibition.—A sale of the effects of the Liverpool Exhibition, extending over four days, has just been held, the net result being that about £10,000 will be realised.

AN ENGINEER'S LIFE AT SEA.—V.

BY A SEA-GOING ENGINEER.

(*Continued from page 147.*)

But time moves on, and our "third" begins to read up for his examination for "second." He has with him a work on marine engines specially written to assist him. In going through the calculations in it, he need not, however, be too much depressed if he finds that his answers often come out wrong, nor need he too hastily conclude that he has "no head for figures" if he finds he cannot always follow the explanations given, for the writer's experience has shown that the best of these books are full of typographical errors. In cases of doubt one of the other engineers may be usefully consulted. Keeping the above in mind may save the student much needless vexation and waste of time. But apart from this, these books are well worth close study. They not only teach the theory of the engines, but give valuable practical information. Without a theoretical as well as a practical side one cannot be a complete engineer. Though good workmen may frequently be met with who are deficient in theoretical knowledge, yet their skill cannot rise higher than the marvellous imitative accuracy of the Chinese, and their uneasy consciousness of this may be detected in the loudness of their boasts of practical knowledge and their contempt for theory. The best of books are, however, only signposts to the study of the engines themselves. To this all the engineer's faculties should be bent. The engine-room must be his school, and the engines themselves his teachers. Their teaching will be found to be strict as well as exact, and they are by no means backward in punishing the inattentive. Apparently on the assumption that adversity is a good teacher, they will sometimes advance a man's education rapidly by giving him hard work during long and sleepless nights. They have a hundred different ways of getting out of order, from hot bearings or troublesome pumps, to a broken shaft, connecting rod, or levers, or perhaps the complete ruin of a low-pressure cylinder. When the engines work well, imaginary cases of disaster may be studied, so that the young engineer may not be taken unawares, but may know in an instant what to do in every conceivable circumstance. When off duty he must compare his ideas with those of older engineers, and by leading them to give their experience of breakdowns he may get invaluable hints and information. He will find also that such information will be of the greatest value to him when passing his examination.

For instance, should a low-pressure connecting rod break, then the high-pressure connecting rod must be removed and put in its place. The two are nearly always made interchangeable. Then the engine must be run as a single-cylinder condensing engine, with boiler pressure reduced. Should there be no bye-pass between the steam and exhaust pipes on the high-pressure cylinder, the high-pressure valve must be removed. The steam in the high-pressure cylinder will now be on both sides of the piston at once, and as the upper side of the piston is of greater area than the lower side, owing to the area of piston rod being taken from the latter, there will be a continuous downward steam pressure on it. This, as well as the weight of the piston and rod, must be reckoned upon, so that the piston must either be allowed to lie on the bottom of the cylinder, or its lashings up must be strong. The reduced pressure of steam to be carried in the boiler will depend partly on the strength of the low-pressure gear and partly on the capacity of the circulating pump, so that there may be no over-heating of the condenser.

Should the low-pressure cylinder or piston be disabled, then the engine must be run as a single-cylinder high-pressure engine, for in most cases, the pumps being driven from the low-pressure crosshead, its stoppage means total loss of vacuum. In this case the chief problem is where to discharge the exhaust steam from the engine. Should the low-pressure crank break, the crank shaft will be found to be so made that it can be turned end for end, with flange and bolt holes ready for bolting to the propeller shaft, which will then be driven from the low-pressure cylinder alone. Should the propeller shaft break, the disaster is usually irremediable on a merchant steamer, but where a spare length of shafting is provided, this, of course, is used to replace the broken one. If the circulating pump should give out, the vacuum can be maintained with a jet condenser, either by opening a sea stop-valve, provided for the purpose, or by drawing some of the upper row of condenser tubes. With a breakdown of the air pump, it is sometimes possible to transform the circulating pump into an air pump, working with jet condenser, as in the previous case. Of course, with breakdowns, repairs, if practicable at all, must be effected as soon as possible, but till then the engine must be kept going as best it can.

In many cases of breakdowns the problem is to find out what has gone wrong, and here the value of previous preparation comes in. In all cases of accident the steam must be at once shut off. Perhaps the engines simply slow down without any sound of breakage. The vacuum gauge must then be instantly consulted. If the vacuum be good, the air pump and condenser are in order, and the slowing has probably been caused by one of the steam slide valves getting adrift on its spindle. A fall of vacuum with a cool condenser shows a defective air pump, while with a hot condenser the circulating pump is shown to be out of order.

Apart from actual breakdowns, the engineer may be troubled with a continuous overflow of water from the hot well, either of sudden or gradual beginning. If the water is colder than usual, and salt, then the condenser requires to be opened, and leaky tubes plugged up at each end. Should the overflow be hotter than usual, and salt, then there is a broken or defective check valve on the boiler. If the water be of the usual temperature of feed, then the feed pumps have gone wrong. Where feed pumps give continual trouble in this way, it may be found that their discharge valves are at their lower end. This allows air to accumulate under the stuffing boxes, and, the pumps refusing duty, the hot well overflows. A temporary cure is to slack back the glands, and allow the air to escape, or to run with slack glands and continual waste of water. A better plan, which has been tried with success, is to lead a small pipe from the upper part of the pumps to the condenser. A cock on this, barely open, will keep the feed pump free of air, and the pump will be found to give no more trouble.

PROPORTIONS OF STEAM BOILERS.

In a recent communication to the Société Scientifique Industrielle of Marseilles, M. D. Stapfer remarked that as he had never met with any good practical rules for the proportions of boilers for steam engines, he had taken the trouble to examine a very large number of different types which were working satisfactorily, and from them had deduced the following rules. The water level in the boilers of torpedo boats was usually placed at two-thirds the diameter of the shell, and in marine, portable, and locomotive boilers at three-fourths this diameter. The surface from which evaporation took place should, however, be made greater as the steam pressure was reduced, that was to say, as the size of the bubbles of steam became greater. To produce 100lb. of steam per hour at atmospheric pressure this surface should not be less than 7·32 square feet, which may be reduced to 1·46 square feet for steam at 75lb. pressure, and to ·73ft. for steam at a pressure of 150lb. It is for this reason that triple-expansion engines can be worked with smaller boilers than were required with engines using steam of lower pressure. The amount of steam space to be permitted depends upon the volume of the cylinders and the number of revolutions made per minute. For ordinary engines it may be made a hundred times as great as the average volume of steam generated per second. The section through the tubes may be one-sixth of the firegrate area, when the draught is due to a chimney from 27ft. to 33ft. high, which in general corresponds to a fuel consumption of 12·3lb. of coal per square foot of grate surface per hour. This area may be reduced to one-tenth that of the grate when forced draught is employed, but for flue boilers without tubes the area through the flues should not be less than one-third or one-fourth the grate area.—*Engineering.*

THE MOMENT OF RESISTANCE OF SHAFTS.

In most treatises on mechanics the integral calculus is used for investigating the expression for the moment of resistance of shafts, and if perfect accuracy is required this is the only way; but it is nevertheless instructive and interesting to work the question out by ordinary mathematics, and then to note how very nearly we come to the accurate result found by the aid of the calculus.

SOLID SHAFTS.

Consider the shaft to be made up of a number of concentric rings equal in width, and let us assume that the stress which exists in the middle of each ring is the same all over the surface of that ring. This will simplify matters very much, and if we were to divide our shaft into a very large number of rings, we should get a very close approximation to the real facts of the case. For the purpose of illustration we shall only suppose the shaft to be cut up into ten concentric rings, in order not to make the calculation too confusing in its detail.

Commencing with the stresses, if we put (S) to represent the co-efficient of resistance of the material of the shaft—*i.e.*, the stress to which the material at the surface of the shaft is subjected, then as the stresses will vary as their respective distances from the centre, we see that the stresses will be (commencing with the middle of the outer ring)—

$$\cdot95\ S;\ \cdot85\ S;\ \cdot75\ S;\ \cdot65\ S;\ \cdot55\ S;\ \cdot45\ S;\ \cdot35\ S;\ \cdot25\ S;\ \cdot15\ S;\ \text{and}\ \cdot05\ S.$$

The area of each ring is equal to the continued product of its mean diameter, the constant 3·1416, and its width (which is, in our case, $\frac{1}{20}$ of the diameter of the shaft).

Now, the *mean* diameter of the respective rings is $\cdot95\ d$; $\cdot85\ d$; $\cdot75\ d$; and so on to $\cdot05\ d$; and as the width of each ring is $\cdot05\ d$, we get for the area of each ring—

$$\cdot95\ d \times \pi \times \cdot05\ d$$
$$\cdot85\ d \times \pi \times \cdot05\ d$$
$$\cdot75\ d \times \pi \times \cdot05\ d$$

And so on to $\cdot05\ d \times \pi \times \cdot05\ d$ ($\pi = 3\cdot1416$).

Now, the mean radius of each ring is—

$\cdot475\ d$; $\cdot425\ d$; $\cdot375\ d$; $\cdot325\ d$; and so on to $\cdot025\ d$;

so that if we multiply the stress in each ring by its area, we obtain the resistance of that ring.

This in its turn multiplied by its mean radius gives us the moment of resistance of the ring. The sum of these moments will then give us the moment of resistance of the shaft to torsion.

Thus :—

Stresses × area of ring × radius = moment.

$$\cdot95 \times (\cdot95\,d \times \pi \times \cdot05\,d) \times \cdot475\,d = \cdot021434\ (\pi\ d^3s).$$
$$\cdot85 \times (\cdot85\,d \times \pi \times \cdot05\,d) \times \cdot425\,d = \cdot015353\ \text{do.}$$
$$\cdot75 \times (\cdot75\,d \times \pi \times \cdot05\,d) \times \cdot375\,d = \cdot0105468\ \text{do.}$$
$$\cdot65 \times (\cdot65\,d \times \pi \times \cdot05\,d) \times \cdot325\,d = \cdot0068656\ \text{do.}$$
$$\cdot55 \times (\cdot55\,d \times \pi \times \cdot05\,d) \times \cdot275\,d = \cdot00415937\ \text{do.}$$
$$\cdot45 \times (\cdot45\,d \times \pi \times \cdot05\,d) \times \cdot225\,d = \cdot002278\ \text{do.}$$
$$\cdot35 \times (\cdot35\,d \times \pi \times \cdot05\,d) \times \cdot175\,d = \cdot0010718\ \text{do.}$$
$$\cdot25 \times (\cdot25\,d \times \pi \times \cdot05\,d) \times \cdot125\,d = \cdot0003906\ \text{do.}$$
$$\cdot15 \times (\cdot15\,d \times \pi \times \cdot05\,d) \times \cdot075\,d = \cdot000084375\ \text{do.}$$
$$\cdot05 \times (\cdot05\,d \times \pi \times \cdot05\,d) \times \cdot025\,d = \cdot000003125\ \text{do.}$$
$$\textit{Sum of the moments} = \cdot0621875\ \pi\ d^3s.$$

$= \cdot1954\,d^3s$, which is very nearly equal to $\cdot1963\ d^3s$, or $\frac{d^3s}{5\cdot1}$ the usual formula employed, obtained by the method of the integral calculus, or by the above plan if an infinite number of rings were taken.

HOLLOW SHAFTS.

Now let us take the case of a *hollow shaft.* If we think for a moment, we may easily see that we can treat a hollow shaft in a precisely similar manner ; that is, we may first work up the moment of resistance of the shaft, treating it as solid, and then subtract from this the moment of resistance of the portion which is cut away.

Now we have seen that the moment of the solid shaft is (using the accurate value for S)

$$M = \cdot1963\ D \times {}^3S \quad (1)$$

where D = external diameter and S = stress,

and the moment of resistance of the portion cut away is

$$m = \cdot1963\ d^3\ f \quad (2)$$

where f is the stress existing at *its* surface.

As the stresses vary in proportion to their respective distances from the centre, the stress

$$f = \frac{d}{D} \times S \quad (3)$$

where d and D are the inner and outer diameters of the shaft. Substituting this in equation (2), we get

$$m = \cdot1963\ d^3 \times \frac{d}{D} \times S$$
$$= \cdot1963 \times S \times \frac{d^4}{D} \quad (4)$$

Subtracting m from M, we get

$$M_1 = \cdot1963 \times S\,(D^3 - \frac{d^4}{D})$$

or, what is the same thing,

$$M_1 = \cdot1963 \times S\left(\frac{D^4 - d^4}{D}\right) \quad (5)$$

which is the usual formula for hollow shafts.

The s.s. Etruria.—The Cunard steamer Etruria, which reached the Mersey on Saturday afternoon, landed at Queenstown her mails, consisting of 575 sacks, which were delivered in London on Saturday afternoon. This is the first instance on record where mails leaving New York on a Saturday have been delivered on the following Saturday in London.

SOME PRACTICAL HINTS TO AMATEUR LOAM MOULDERS.

In this article we will endeavour to place before our readers (especially moulders who are desirous of knowing something of loam moulding, but who are kept back by the jealousy of their fellow moulders) a few practical hints on loam moulding. We will endeavour to give a clear and precise method of moulding, showing the method of mixing the loam, and its proportions, in such a way as to enable any moulder with tact to produce good sound loam castings. It is a well-known fact that very few moulders, in comparison to the whole number in the trade, understand the art of loam moulding, and the writer believes that not one moulder in three hundred understands this branch of the work. There is no doubt that loam moulding would be more generally understood but for the fact that many foundries have not the necessary stove accommodation.

We will take as examples two small articles of a simple pattern, such as a tup and a cone pulley, according to sketch and dimensions given, and will go through the steps required to mould them in loam. Dealing with the tup, as shown in figs. 1 and 2, the patterns required to accomplish this mould will be first considered. Fig. 3 is the board to strickle out the exterior of mould, as shown in fig. 6. Fig. 4 shows the board for strickling the top of mould, as shown at A, fig. 1. Fig. 5 is core box for B, fig. 1. Fig. 6 shows the mould built up, with the board, fig. 3, attached.

Before moulding can be commenced, we require a centre plate and spindle. The spindle should be, say 6 feet long and 2⅛ inches diameter, and on it should be placed a movable arm of wrought iron, with a set screw, as shown in fig. 6. The plate should be oblong, about 24 inches long and 18 inches wide, and should have four feet on the underside about 6 inches long, for support, as shown at C, fig. 6. This plate should also have a taper hole in the centre, to admit the taper end of spindle.

The plate must be laid down perfectly level. If the floor is hard where the mould is to be worked, pack the feet until level. If the mould is worked on the foundry floor, it will be necessary to ram the foundation sand well, or it will be liable to sink when the weight of mould is upon it. The plate being levelled and spindle in position, take four thin packings and place one on each corner of the plate. We next require an open sand plate, as fig. 7, which should have a hole in the centre, say 3½ or 4 inches diameter, for the spindle to pass through freely; it should have four lugs to lift it by, and have short prods, about one inch long, cast all over one side. Before casting, thrust some pieces of furnace coke in the bed ; these will form holes, to allow the air or gas to escape. If the tup is to be 24 inches diameter, then the plate should be about two inches thick. Place this plate in position, as shown at K on fig. 6, and clay wash it on the top side intended for building upon. Cover with building loam, and commence to put on a layer of bricks.

The composition of the building loam, or mortar, is black sand and clay wash. This should be mixed together to about the same thickness as bricklayers' mortar. These bricks, when laid on the plate, should have a space between each row for the insertion of small cinders, as at S, fig. 6, which allows the air to escape more freely when casting. The bricks should also be kept about one inch from the strickle board all round, to allow for the loam. It is essential to have a strengthening plate about one inch thick, as at P, fig. 6, and also to have the runner near the bottom of the mould ; and seeing there is a great thickness of bricks, we would recommend a loam brick to be built in the coping, with a runner gate sawn in, as shown by fig. J. If the mould is built up omitting the loam brick, and the coping imperfectly dried, there is a great risk of the casting being scabbed or blown, but by using the loam brick no fear need be entertained on this score. A runner gate 2½ inches by ⅞ inch would be sufficient for this casting, with two risers to relieve the strain which would otherwise result with so large a body of metal to confine.

After the coping is built up, we next apply strong loam. The composition of this loam is red sand—parting sand—and horse-droppings; and the mixing is in the proportion of one barrow of red sand to two barrows of parting sand and three sieves of horse droppings. These ingredients are all ground together in a mill, but not too fine, as the loam is required to be very porous. When this strong loam is applied all over, and strickled round, we then mix up a quantity of much thinner loam of the same ingredients, and apply it over the strong loam, and again work the strickle board round. This loam forms a smooth surface.

The mould is then placed in the stove to dry, after which the board, fig. 4, may be applied to the spindle, and the top of the plate strickled, as shown in fig. 8. The same process is here gone through as in fig. 6. When the exterior or coping of mould and top plate are thoroughly dry, the mould is gently sand-papered, and all cracks filled up and trimmed. These cracks are caused by the drying, through the application of horse-droppings. Next, black the mould and slake it, and again dry it; after which place the core, B, in position, and put on the covering plate. The whole mould being now put together, a hole is dug in the foundry floor and the mould inserted. A circular piece of old boiler-plate is then put round, bolting each end together; sand is then rammed thoroughly well all round the mould, for the purpose of resisting the strain when casting. There is no danger in ramming the outside well, as the air or gas can escape to the outer casing brickwork through the cracks occasioned by drying. In all foundries where bolts are available they should undoubtedly be used for bolting down purposes.

We will next deal with the cone pulley of the type shown in figs. A and B, and will suppose the cones to be, say 27, 24, and 21 inches diameter respectively. As these pulleys are very thin, extra care must be taken in venting the mould.

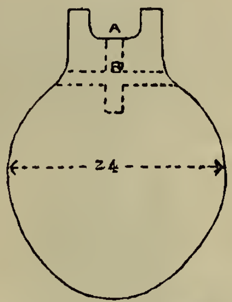
The same centre-plate and spindle, also the same open sand-plate used for moulding the tup, may be used for the pulley. First consider the patterns required to accomplish this mould. Fig. C shows the board for strickling the coping of mould, and fig D the board for strickling the core. Fig. E is a bracket, and fig. F a gauge stick. This gauge stick is used to set the strickle boards to the exact diameter required. Fig. G is the boss, as shown at G, fig. A, and fig. H shows snug, H, figs. A and B. Fig. I shows the coping of the mould, and fig. K the core, each built up with board attached. Fig. L is a strengthening plate, with long prods.

Having now supplied ourselves with these requisites, we will deal with the method of moulding. In the first place, the centre plate and spindle are laid down just in the same manner as with the tup. Next take the same plate, with prods to build the coping upon, and having attached the coping board, fig. C, commence to build the coping as shown at fig. I. Seeing there is a good thickness of brick at the bottom, we may follow the method adopted in the tup, and apply a loam brick made for the purpose, and saw a passage through the lengthway of the brick to the size of runner required, as shown on fig. J. The runner in this case should be about 2½ inches long by ⅝ inch wide. Unless this loam brick is used (most probably the ordinary runner passage is not dried as well as it might be), there is liability to have a blown casting. Such castings the writer has frequently seen, when they have been urgently wanted, and the loam brick not applied.

Let the runner be at the bottom, with two risers, and well fed. The runner is shown on fig. I. The bricks must be built in the same manner as in the tup, leaving spaces between for the cinders until the whole mould is built up. There should also be small bunches of hay laid or built round the mould at each step of the pulley; when this is done the ends of the hay should come to the outside of mould or bricks, and when the mould is inserted in the stove to dry all these are burned out and crevices are left which allow the air or gas to escape more freely. In building up the core great care must be taken, as it will require to be turned over, and therefore an extra plate near the top with long prods, as shown on fig. L and also on fig. K, must be provided. Fig. L shows four bolt holes; these correspond with the bolt holes in the plate, fig. 7. When this plate is applied it should be bolted to the bottom plate, O, thereby enabling the core to be turned over without risk. The plate, fig. L, must be with holes cast through, and also the bricks should be built in the same way as the coping, with cinders interspersed, and the plate, O, should also have plenty of holes cast through. By attending well to the venting there is every likelihood of having a good casting. The boss, fig. G, must be built in, as also the four brackets, fig. E, while the core is being built up. When the coping and core are built up, they must be dried in the stove. After drying, the same process of trimming and blacking are gone through, also the same method of ramming in the floor and casting as with the tup.

On fig. 6 and fig. I is shown the manner of applying the runner. Great care should always be taken not to have the runner too large, or the supply cannot be kept up; and again, if large, the scum of the metal goes in the mould. Any of our readers (who are moulders) adhering to the instructions here given need not fear producing good sound loam castings.

FIG. 1



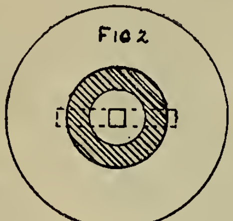


FIG. A

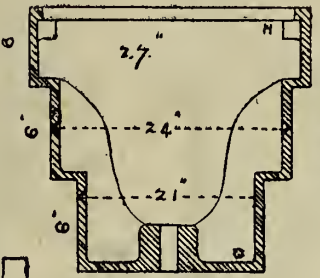


FIG. B

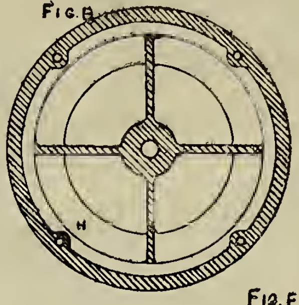


FIG. F

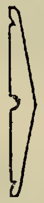
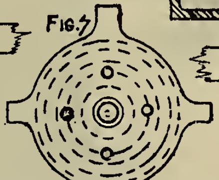
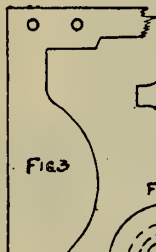
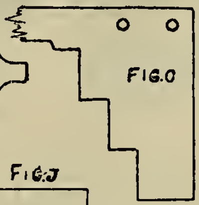


FIG. 7







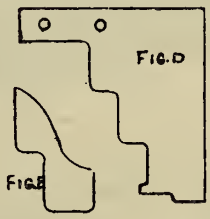


FIG. L

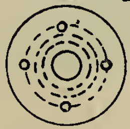
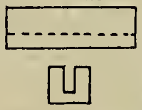


FIG. J



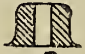


FIG. G

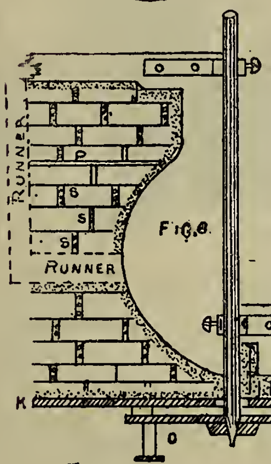


FIG. 6'

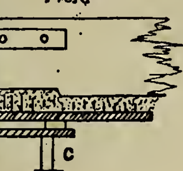


FIG. 4

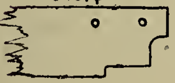
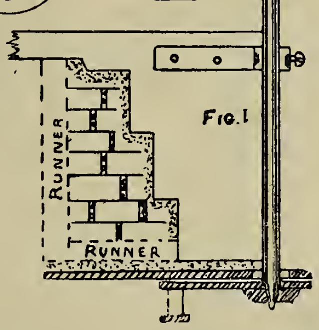
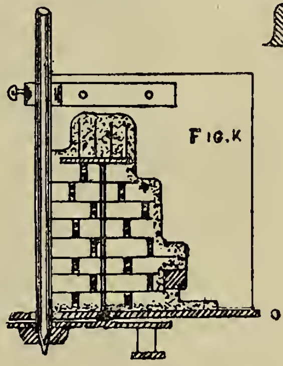


FIG. 5



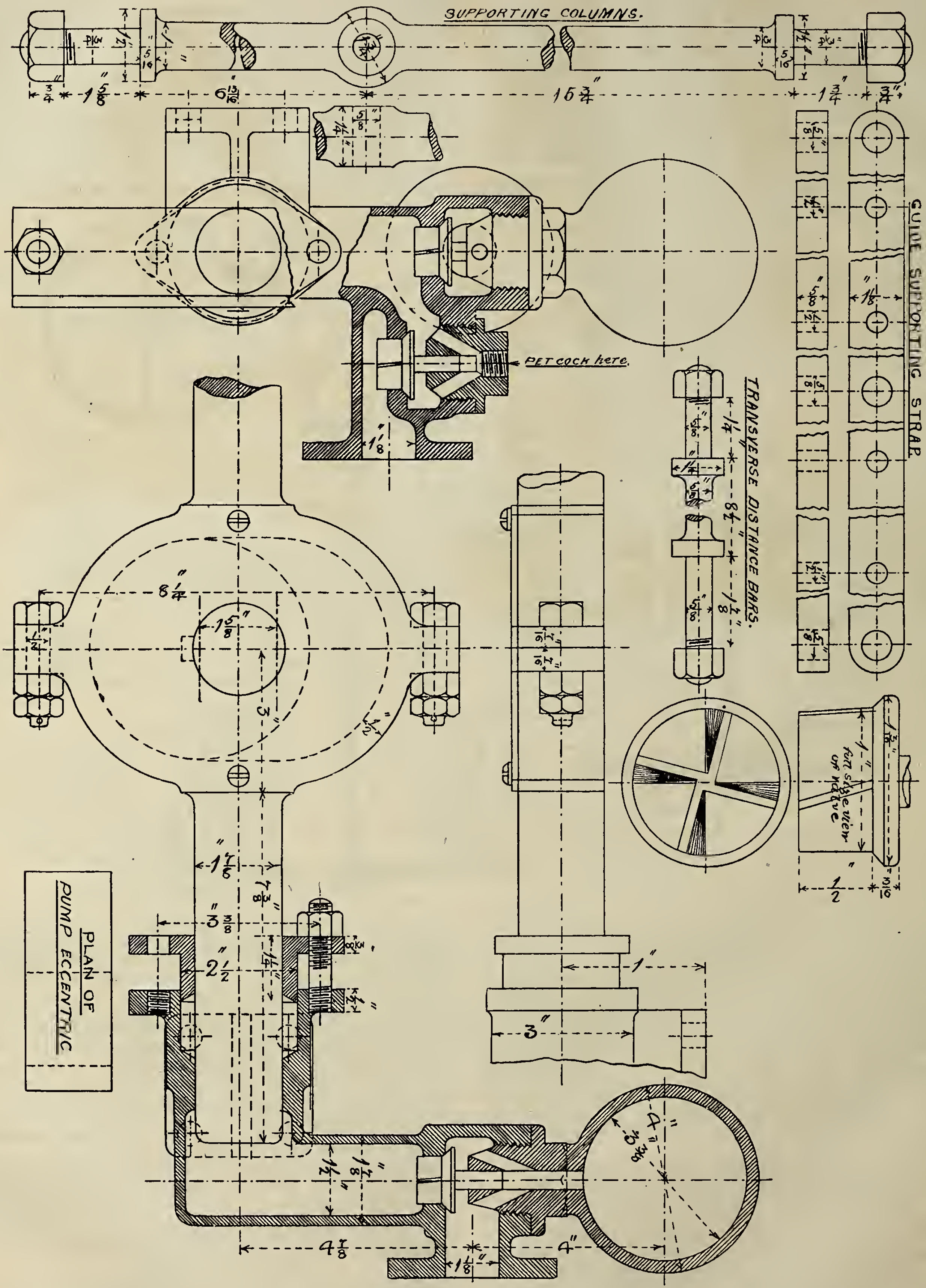


Quick Passage from Australia.—The Peninsula has made the voyage from Adelaide in 662 hours, a distance of 7,721 miles. Deducting stops, the speed was 17·5 miles per hour.

WORKING DRAWINGS.

LAUNCH ENGINES.—IV. Details of Feed Pumps, Columns, &c.

Scale, 4in. = 1ft.



Working Drawings.—We this week present our readers with the fourth of the series of working drawings of a launch engine. The previous sets of drawings appeared in our issues of December 9th, January 20th, and March 23rd.

THE "ALMA" LOCK-NUT.

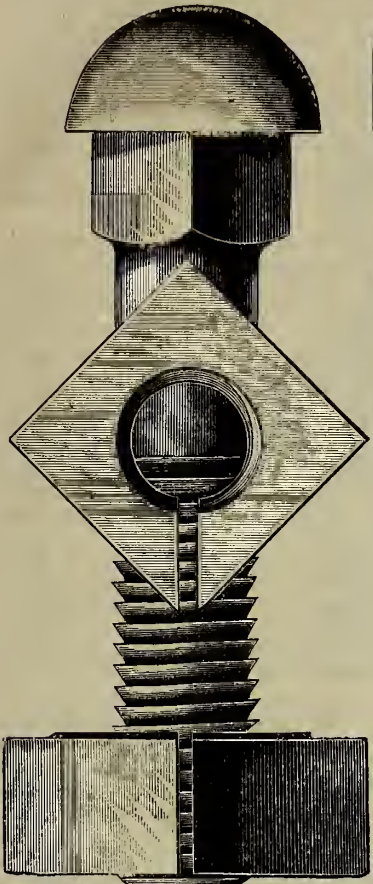


Fig. 1.

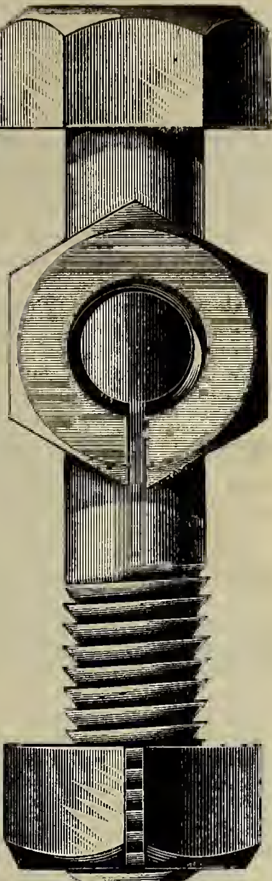
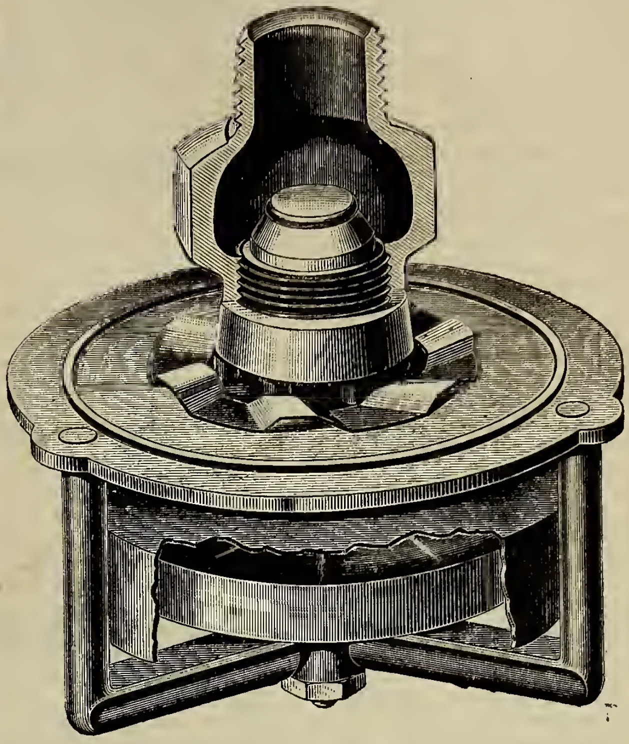


Fig. 2.

THE illustrations herewith represent a new lock-nut, manufactured by Messrs. Horton and Sons, Alma Works, Darlaston. The principle of the nut is Hawks's patent. The thread is that known as the buttress type, having a bearing surface at right angles to the direction of stress, the same as a square thread, and thus obviating any tendency to burst the nut when the latter is screwed tight. It is obvious that this or a similar form of thread is a necessity with such a nut as those shown in the engravings, on account of the split side. The nut is made slightly smaller than the bolt, so as to fit tightly, but not so hard that it cannot be screwed up with an ordinary spanner. If it is desired to run the nut down by hand, a small key, made out of a piece of steel wire, bent at right angles, and having one prong flattened a little at the sides, is simply inserted in the slit in the nut and twisted half round, which is quite sufficient to spring the nut and give the necessary amount of play to allow the nut to be run off or on easily by the fingers ; one such key will, of course, fit any size of nut. This nut offers very easy means of removal in case of being rusted on, which in other forms would entail the destruction of the nut and bolt. A chisel can always be driven in the slit, then the threads can be oiled through the slit, and a spanner will readily fetch the nut off. This facility is most advantageous for large bolts, as on railway trucks, drawbars, fishplates, &c. We may mention also that the form of thread allows of almost all the stress being used for tightening purposes, instead of a large proportion being wasted on the nut or locking device, which is obvious in the double nut and other forms of lock-nut.

The "Alma" nut has been fully tested on the fishplates of one of our main lines of railway, as well as a branch line, for six months, and, we are informed, there has been no occasion to use the spanner to tighten them up to the present date. Ordinary bolts and nuts under the same conditions require attention every few days, while bolts with double nuts often require fresh screwing up. Fig. 1 shows a nut and bolt of this character, and fig. 2 represents a finished bolt with hexagon nut, suitable for engine and general machine work. The makers are prepared for a large output per week of all forms and sizes to meet customers' requirements.

THE "DRAPER-HETHERINGTON" SPRINKLER.



THE "Draper-Hetherington" Sprinkler is made on a new plan, entirely differing from the generality of sprinklers in use, which depend on a metallic joint, fusible at a certain low temperature. These latter are so constructed that the pressure of the water constantly tends to force the valve open, and hence they are liable to leak ; besides which, an accidental knock with a brush in sweeping down will frequently disarrange the parts, and sometimes cause serious trouble. The sprinkler illustrated by our engraving depends for its action on the expansion of a fluid, which at a certain temperature is sufficient to open the valve and allow the water to escape. This fluid can be proportioned so as to be operative at as low a temperature as 120° F., but is ordinarily set for 140° F., which is much lower than that usual with sprinklers depending upon the fusion of an alloy, and is, therefore, a very important item in its favour, considering that the first few seconds in the starting of a fire are of vital importance, and remembering also that no sprinkler of whatever kind will control a fire once it has got thorough hold. The sprinkler does not become inoperative through age, as the liquid is hermetically sealed in a metal case, and is indestructible and changeless. When in its normal condition, the pressure of the water is on the valve seat, and so keeps it closed ; but when sufficient heat to open it is generated, the fluid chamber is expanded, forcing the valve open against the pressure of the water in the pipes, and so operating in the usual way. When it has accomplished its purpose and put out the fire, the valve closes automatically, and is immediately ready, without any attention, for another fire. The latter advantage is one that will be thoroughly appreciated, we believe, by all millowners, who are mostly interested in this kind of apparatus. The makers are Messrs. Hetherington and Co., Ancoats Works, Manchester.

COMPRESSED OIL-GAS AND ITS APPLICATION.*

IN considering this system of illumination, its applicability to buoys, isolated beacons, lighthouses, and railway carriages, &c., the author treated it under the primary heads of mode of manufacture, illuminating properties, cost, storage, and transit, and in doing so he referred to the early history of oil-gas, and the patents taken out from time to time in connection with the system. It was stated that in 1825 Faraday contributed a paper to the Royal Society "On New Compounds of Carbon and Hydrogen, and on certain other Products obtained during the Decomposition of Oil by Heat.” That communication, however, dealt with the chemistry of oil-gas. It was mentioned in that paper that 1,000 cubic feet of good gas yielded nearly 1 gallon of hydro-carbon. The gas from which the hydro-carbon was obtained was manufactured by the Portable Gas Company, and was compressed to 30 atmospheres. It was drawn from a gasholder, and passed over water into a large and strong receiver, and from it into portable vessels, the principal condensation taking place in the receiver. The oil-gas manufactured by the Portable Gas Company was not distilled from shale oil or petroleum, but from other oils and fatty substances, mineral or vegetable. Between the years 1792 and 1883 numerous ingenious patents were taken out for manufacturing and compressing oil-gas for lighting and heating purposes. Oil or hydro-carbon gas was the product of heavy petroleum or shale oil once distilled. It had a specific gravity of about ·840, and flashed at about 220 deg. Fahrenheit. In detailing the process of the manufacture of oil-gas, the author described the works erected at the South Foreland by Pintsch's Patent Lighting Company, Limited. The illuminating intensity of oil-gas might be taken at from 40 to 50 candles when burned in a London standard argand burner, with a consumption of 5 cubic feet per hour, under a pressure of 0·5in. of water. The price varied from about 5s. 6d. to 16s. per 1,000 cubic feet, being directly influenced by the quantity of gas produced, the management of the retorts, and the price of oil, fuel, and wages. Until the adoption of oil-gas for their illumination, buoys and isolated beacons were only useful for the purposes of navigation by day; but they were now equally so by night (in clear weather), enabling vessels to navigate with safety intricate channels, which hitherto could not have been attempted except at considerable risk. Gas-buoys, as at present used by the Honourable Corporation of Trinity House, were constructed of best mild steel; they were spherical, 9ft. in diameter, and surmounted by a light wrought-iron superstructure, carrying a lantern enclosing the illuminating apparatus. The total weight of one of these buoys complete was about 80 cwt., the weight of the buoy being 78¾ cwt., and that of the illuminating apparatus 1¼ cwt. The buoys were usually charged to a pressure of five or six atmospheres, or from 75lb. to 90lb. pressure per square inch. The gas was contained in the spherical portion of the buoy, the capacity of which was about 382 cubic feet, and was consumed at the rate of 0·75 cubic foot per hour, burning night and day continuously. When fully charged to five atmospheres, and burning at the above rate of consumption, the light would be maintained for one hundred and six nights and days. The intensity of the light was from 17 to 20 candles through the lens. The estimated cost of a first-class gas-buoy, including the lantern and illuminating apparatus, also royalty, was about £420. In a new form of gas-buoy, constructed wholly of mild steel, it was intended to carry the gas in the lower portion of the buoy. The capacity for storage of gas would be 383 cubic feet, which, at a pressure of five atmospheres, would sustain the light (consuming 0·75 cubic foot per hour) for one hundred and six nights and days. The advantages of this form of buoy were improved stability and its applicability to the recently adopted uniform system of buoyage. The estimated weight of this buoy was about 6 tons, without moorings. In 1885 the Canadian Government adopted a combination of the bell and gas-buoy for service in the Gulf of St. Lawrence, the bell weighing 3 cwt., giving the usual warning by day and night, supplemented by the light. The gas was stored in a welded cylinder (independent of the buoy proper) having a capacity of 339 cubic feet. The cylinder, when charged to six atmospheres, was capable of maintaining the light for one hundred and thirteen nights and days. The weight of the buoy complete was 9½ tons. In 1881, a beacon, lighted automatically by compressed oil-gas, on Pintsch's system, was adopted by the Clyde Trust Commissioners, who had recently erected another on the Gantock Rock, off Dunoon, on the Argyleshire coast, and who were extending this system of illumination at Cardross and Dumbuck lighthouses, Donald's Quay, Rashilee, and Dalmuir light-towers. In December, 1885, two iron lighthouses, similar in construction, were erected by the Trinity House, one at Stoneness, opposite Greenhithe, and the other at Broadness, on the Thames estuary. At Stoneness Lindberg's system had been adopted, the burner for producing the light being that of Lyth, of Stockholm. The light burned day and night at full power, showing a white light with short occulation at periods of about five seconds. A description of this system was given. The first cost of Stoneness Lighthouse had been £630, and the cost of its annual maintenance was £88. Broadness light was produced by the combustion of compressed oil-gas. The intensity of the flashes at Stoneness was about 60 candles, and at Broadness about 500 candles. The first cost of Broadness Lighthouse had been £1,026, and the cost of its annual maintenance was £128. Both Broadness and Stoneness Lighthouses were under the charge of a boatman, who visited them at least twice a week, when he adjusted and cleaned the apparatus. These systems being comparatively new, no reliable comparison had yet been made as to their relative efficiency. An important installation of an oil-gas apparatus for lighting and fog signalling had recently been made by the Commissioners of Northern Lighthouses at Ailsa Craig, on the Firth of Clyde (Min. Proc. Inst. C.E., vol. lxxxix., p. 297), the first cost of which had been £24,000, while the cost of its annual maintenance was £725. There were now two hundred and fourteen buoys, lightships, beacons, and other lights in use in various countries on Pintsch's system.

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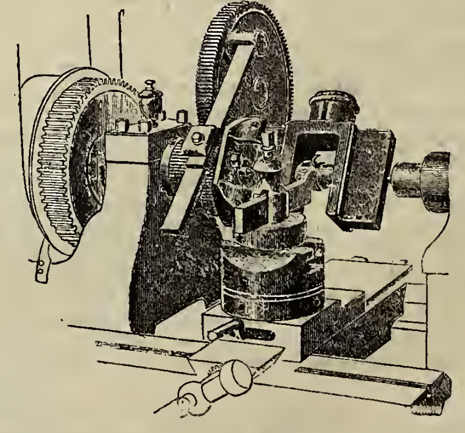
* Paper read before the Institution of Civil Engineers by Mr. Arthur Ayres.

The author next dealt with the application of compressed oil-gas to the lighting of railway carriages, which he stated was one of growing importance. It was probably first tried in the year 1871, with satisfactory results, in Germany, on the Lower Silesian Railway, and in England in 1878, on the St. John's Wood trains of the Metropolitan Railway, with equally satisfactory results. The Great Eastern Railway Company was the next to adopt it, the Metropolitan Railway Company definitively adopted it for the whole of its rolling stock a few weeks later, and other companies quickly followed suit. The systems chosen were those of Messrs. Pintsch and Messrs Pope and Sons, which differed but little from each other. Some trials were also made of Messrs. Bower's system on the Great Northern Railway. The gasholders were attached either to the roofs or to the under-framing of the carriages, and were charged to a pressure of from six to eight atmospheres. The gas was conveyed to the roof-lamps by pipes from the gasholders, passing through a contrivance for regulating the pressure at the burners, one such regulator being attached to each carriage. There were now twenty-three thousand four hundred and ninety-nine carriages so illuminated on Pintsch's system, and two thousand seven hundred and ninety-one on Pope's system. Taking the double journey between Euston and Aberdeen, the cost of compressed oil-gas was 0·0404d. per lamp per hour, and for the ordinary oil system 0·385d. per lamp per hour, showing a greater cost of the ordinary oil system of 0·3446d. per lamp per hour, or 8½ times more than oil-gas.

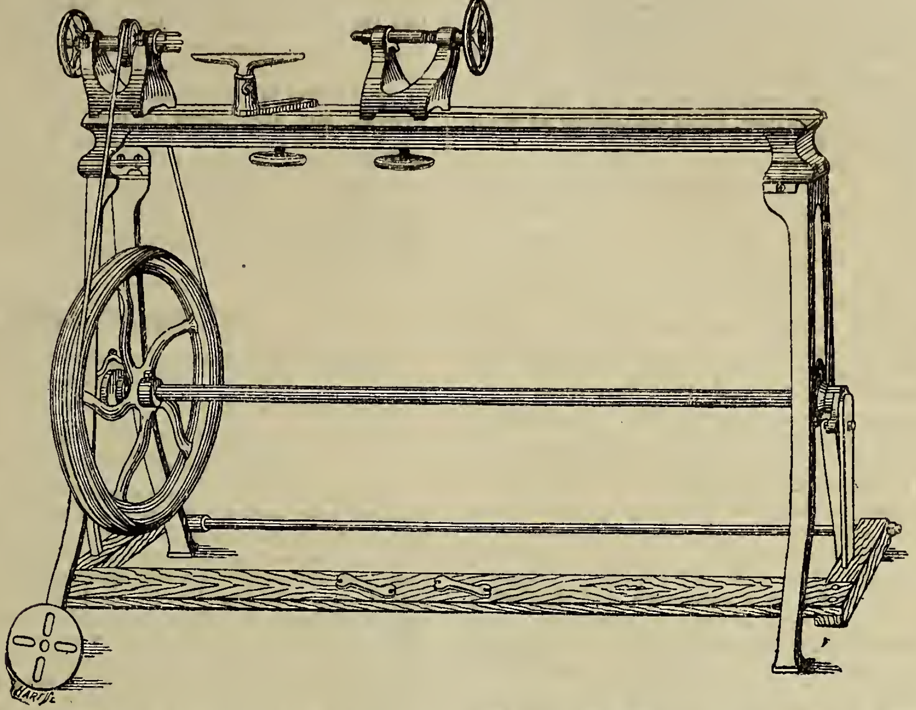
LATHE ATTACHMENT FOR TURNING CROSSHEAD PINS.

The device illustrated herewith seems a handy tool for a kind of work the doing of which is generally little better than drudgery. It is an attachment that can be applied to any lathe of ordinary make, and used for turning crosshead pins, not only (says the *American Machinist*, to whom we are indebted for the illustration) saving much of the time usually required for such work, but doing the work in a superior manner. It consists of a tight pinion securely fastened on one end of a sleeve, this sleeve having a thread inside of it, so that it can be secured on the lathe spindle in place of the ordinary face plate. There is also a loose pinion and a chuck adjustably secured to it, adapted to rotate on the sleeve of the tight pinion, and a large gear-wheel intermeshing with the tight pinion, and operating a rack pitman which intermeshes with the loose pinion, rotating the loose pinion and attached chuck back and forth. In operation the crosshead is centred on the ordinary lathe centres, and secured in the chuck so that they rotate forward and back together. The cutting tool is an ordinary lathe tool, mounted in the lathe tool post, and operated by the lathe feed in the usual manner. At each forward movement of the crosshead the tool



NEW WOOD-TURNING LATHE.

CONSTRUCTED BY THE BRITANNIA COMPANY, COLCHESTER.



cuts about five-eighths of the distance around the pin, and when one side of the pin is turned the crosshead is reversed in the lathe, and the opposite side turned, completing the pin. It is not necessary to remove the back gear of the lathe to attach this device, consequently the operator can use any desired speed. If he is turning a steel pin, and wishes to run the lathe slow, he can do so. The machines are giving satisfaction, and doing the work in about one-third the usual time.

NEW WOOD-TURNING LATHE.

The above figure represents a very cheap lathe, constructed, expressly for wood-turning, by the Britannia Company, Colchester. Its chief interest lies in its marvellously low price—£4 10s. only for a lathe of 5in. centres, made entirely of metal, with the exception of the treadle-board. The metal is economised without the sacrifice of strength. The heads are hollow coned out castings, milled to fit on, and slide over the V'd edges of the planed bed, whose cross section is rudely like that of a hollow triangle, the base being uppermost. Provision for taking up the wear of the mandril of the fast headstock is made by means of divided bearings and pinching screws. The driving cranks are placed outside the standards. The bed stands 36in. high; the total length is 4ft., and the distance between centres 36in. A 5in. face-plate, fork-chuck, T rest, spanner, and belt are supplied with each lathe. The total weight is 144lb. This cannot, of course, take rank with the first-class lathes manufactured by the same firm; such would be impossible at the price, but all the wearing parts are properly fitted and finished, and there is no doubt that it is the very cheapest iron lathe in the market of this size. For all ordinary wood-turning it is sufficiently stable, true, and free-running.

THE MANCHESTER STEAM USERS' ASSOCIATION.

The annual meeting of the members of the Manchester Steam Users' Association was held on Tuesday, at the offices, 9, Mount Street; Mr. J. Ramsbottom (Alderley Edge) in the chair. The annual report, which was read by the secretary (Mr. R. Tonge), stated that the number of members of the association on the 31st December last was 1,674; the number of works, 2,318; and the number of boilers inspected, 4,864. The revenue of the association during the twelve months from subscriptions, special service fees, &c., had been £11,178. The number of works and boilers under inspection stood higher than at any previous period. The revenue was the highest yet attained, and exceeded that of the previous year by the sum of £143. There was a net surplus of income over expenditure of £1,056. This had been carried to the reserve fund, which now stood at £11,259. Adding the guarantee of the president and nine other members of the committee, the total value of the guarantee fund was now £21,259. The special service available to the members when laying down new boilers had been largely sought during the past year. Boiler pressures were steadily rising, and it became more and more important that the design and construction of the boilers should be in every respect equal to the demands for the increasing pressures. By the preparation of specifications, the superintendence of the construction of the boilers, including the testing of the plates, &c., the association served its members and promoted improved "boiler engineering." During the year no explosion arose from any boiler under the inspection of the association. The committee had to record, however, that 40 steam boiler explosions arose from boilers not under its inspection, killing 26 persons and injuring 43 others, while 18 "miscellaneous" explosions occurred from the bursting of bleaching kiers, drying cylinders, economisers or feed-water heaters, steam pipes, kitchen boilers, &c., killing 14 persons and injuring six others, making a total of 58 explosions, 40 deaths, and 49 other cases of personal injury. The following resolution was unanimously adopted after a brief discussion: "That this meeting desires to express its increasing confidence in the principle of competent periodical inspection as a means of preventing boiler explosions, with their attendant loss of life, and therefore requests the president and committee of this association to persevere in their endeavour to secure the introduction of a suitable measure in Parliament that shall bring every boiler in the United Kingdom under competent periodical inspection, but at the same time urges that such inspection should not be carried out by the Board of Trade, but by lay institutions."

The Germans appear to be very much annoyed that an Englishman should be entrusted with the artistic direction of the workmen engaged in the preparation of the Schloss for Her Majesty's visit. Apparently, however, it had been rumoured that a whole body of English workmen had also been engaged, which was more than the Chauvinists could stand, and afforded them a welcome handle to get hold of wherewith to charge the Empress again with undue partiality to everything English.

DRY SEASONS AND THEIR EFFECTS ON STEAM BOILERS.

In the selection of a site for a large works where much steam power is required, one of the greatest difficulties often to be overcome is how, when, and where to get a suitable supply of water for boiler purposes. A particular supply may be clean and free from much solid matter, but quite unsuitable on account of its chemical impurities; and, on the other hand, it may be free from these very deleterious agents or impurities, while containing so much solid matter as to endanger the furnace crown plates from overheating. Seldom indeed does it occur in our somewhat overcrowded districts that a source of feed-water can be found that is free from the above, or at anyrate so free from acids or solid matter as not to require some treatment either of the nature of an anti-corrosive or a disincrustant character. Usually, under ordinary circumstances and during a season of average rainfall, no great difficulty offers itself by way of regular treatment when once the best antidote is known, but during a dry summer and autumn, such as we have just passed through, sad havoc is played with many boilers, the result only being found out afterwards. A few cases that have come under the writer's observation are perhaps worth notice. A number of boilers made by a firm of repute about three years ago were recently found so corroded as to be considered beyond repair, and consequently had to be renewed. Of course, as may naturally be expected, the owners thought they had not had proper attention, either from their own attendants or the insurance company; but at the same time a doubt existed as to the quality of material used, considering that the same men and insurance company had given entire satisfaction for years previously, and the boilermakers were men of the first rank, and the material mild steel beyond question. A reasonable consideration sufficed to show the cause of corrosion was something quite unusual and unexpected, and was only discovered too late to save the plates.

Just about the same time four boilers about four years old, made under patent right as modified Lancashire boilers, were found leaky in the furnaces, and, as in many other cases, were allowed to work on as long as possible, when an examination revealed a worn-out inside. Here all kinds of lamenting was heard, everybody was blamed—the makers, the patentees, the designers, those who had selected the material, and the insurance inspector in particular; but to the experienced individual there was no mystery about the matter. How could the maker be blamed when there was not a leaky seam, loose rivet, slack stay, or trace of bad workmanship to be found? Why blame the patentee, or principle on which the boiler was made, when the patented portion had suffered least of any? Why blame the material, which was, in this case, best Yorkshire iron, a well-known brand? And why blame the inspector, who, on his first visit after the dry season, revealed the whole thing?

Still another similar case. Two boilers, ten years old, were known to be somewhat wasted by corrosion, and were carefully watched every cleaning time, with the following result: The engineer, seeing matters were gradually getting worse, and not being able to neutralise the acid impurities, called in the insurance inspector for advice, when, on close examination, it was found expedient to reduce the pressure from 75lb. to 45lb. These three cases were all fed from the same water; so it will be seen that iron and steel, old and new, plain or patent, suffered in the same degree; and no doubt many others, in the same neighbourhood, came to grief in like manner.

Even well waters appear to have suffered some change in the South of England. New boilers were laid down, which worked well for a time, and then gave trouble; the boilers were, of course, thought to be defective, and the grease in feed was also credited with the cause. This was partly removed, but still trouble ensued. The fusible plugs were melted out with full glasses on two occasions, and on another the furnace sides were bulged inwards, which were accepted as unmistakable evidences of something being wrong outside the range of the boilermaker. Certain alterations were made and treatment adopted, when the trouble ceased, although the alteration necessitated a change from hot feed to cold, which considerably increased the coal account.

In the Midland counties a peculiar case occurred some years ago. A well became impregnated with a vicious acid, causing somewhat serious corrosion in the feed-pipes and boiler, which at the time was not considered dangerous; so the acids were removed and feed purified, and an anti-corrosive composition used. All went well until quite recently, when the composition was found most effectual and the boiler rapidly became clean.

The corrosion, which had certainly not increased in depth for many months, was now found more serious than was at first anticipated, for on piercing the plates they were discovered to be less than $\frac{1}{32}$in. thick, while there was not the slightest trace of oxide to be seen, proving that the damage had been done a long time ago. In two other cases the trouble arose from using water which was really little better than puddle. In one case no less than five fractures developed themselves in the roots of flanged seams through overheating, the water gauges being repeatedly choked. In another case the blow-out tap could not be used owing to the sediment becoming so dense on the boiler bottom, and after three or four days' work the only way of emptying the boiler was by taking out the mudhole lid, when shell bottom was found to be 12in. to 18in. deep in solid matter. No doubt these cases are bad, but we fear they are not the worst that have occurred; and they should serve to incite people into a sense of watchfulness during dry seasons, and make them more reasonable in their judgments.

CORRESPONDENCE.

We do not hold ourselves responsible for the opinions of our Correspondents.

HEATED NECKS.

To the Editor of "The Practical Engineer."

Sir,—As you seem to have a considerable number of practical men amongst your readers, I should like to have the experience of some of those who have had much to do with mill-gearing, in reference to the best mode of keeping bearings from becoming overheated. We have some journals in a mill, not long ago started, which cannot be kept cool long at once. We drive by rope gearing, and the bearings on each side the rope pulley on the second motion shaft are continually getting hot. This was probably due, in the first instance, to the journals having been placed too far apart, and the shaft springing, but we have since put in two extra bearings much closer to the rope pulley. This stopped the heating for a time, but the trouble is now again occurring, and baffles all our efforts to cure it. We have had cold water running on the necks, have used a plentiful supply of sulphur and oil and sulphur and tallow, but still the necks overheat, sometimes, however, giving no trouble for a day or two, and then commencing to get hot again. Any hints from some of your experienced readers who have gone through a similar difficulty will be much appreciated by yours, &c.,

April 23. Young Engineer.

TALLOW CUPS *v.* SIGHT-FEED LUBRICATORS.

To the Editor of "The Practical Engineer."

Sir,—While this question of sight-feed lubricating is being discussed, I should like to know if any reader has tried conveying the lubricant directly to parts in contact? I would suggest a "sight" on cylinder, and another on valve chest, or two where expansion is used, with a pipe inside to drip the oil on to valve faces. One pipe from lubricator would supply the three sights, the extra cost of which, I think, would very soon be covered by the saving in oil. I am of opinion that much of the lubricant we get from our "sight-feeds," as at present applied (to horizontal engines especially), passes through the engine without having the desired effect. I should like to know what "Sight-feed" and "Corliss Valve" have to say about the above?—Yours truly,

April 21, 1888. Lubricant.

SMOKE CONSUMERS.

To the Editor of "The Practical Engineer."

Sir,—I have been very much interested with the correspondence on the above, but should like to ask a question which, in my opinion, is of vital importance to seven-eighths of our steam users, viz., Is it possible to generate as much steam in a given time with the assisted draught furnace and smoke consumer as by ordinary hand firing? I know several towns in Yorkshire where the smoke inspectors recommend a patent stoker which in no competitive test has ever come out the best. Query, Why do they recommend it? It is not only a question of preventing smoke being emitted from the top of a chimney, but of economy and power to be obtained from the boiler, and most so-called smoke consumers fail in this.—Yours respectfully,

April 23. Mill Manager.

IGNORANT STOKERS AND ENGINEERS.

To the Editor of "The Practical Engineer."

Sir,—As one of your correspondents in a recent issue said, it seems to be the opinion of a great many people that anyone with enough muscle to throw coal about is a fit attendant to a steam boiler. To show that such is the case, I will give a few examples of both so-called engineers and firemen. The first instance is that of a man *who had been about steam boilers for forty years*, being engaged as fireman at a public institution not 100 miles from Manchester. The first thing he did after entering the boiler-house was to hang his heavy velveteen coat on the end of the safety valve lever. On being told by the engineer that he must hang it on the walls of the engine-house, he made answer that it (the coat) would dry sooner where it was, as it was nearly wet through. "But," said the engineer, "look at the additional weight you have placed on the lever." "Oh," replied he of 40 years' experience, "that's noan mich weight; it only weighs five or six peaunds." Another example of stoker was the man who nearly ruined a locomotive boiler through putting enough tallow inside as to cause severe leakages, and to disable it from running. His plea was that it would stop it from rusting inside. For a sample of a so-called *engineer*, the one I will now mention once fitted a few steam pipes to a range of drying horses in a steam laundry, and allowed the pipes (which were placed one over the other) to go close into a corner of the room where they were situated, and touch the wall so close that when steam was turned on nearly all the joints broke, to the consternation of himself and the women who had charge of that particular department. He nevertheless took all the pipes out except two or three that remained sound, and replaced them with a new lot, fitted them tight against the walls, and went through the same farce as before. On being advised by an observer to allow for expansion, he said to the man who gave him the much-needed information, "I'll co' thee eggspansion, I will," and did so till the time came for him to leave that situation, which was not long after. Another *engineer* was he who was taking a feed valve from off the front end plate of a Cornish boiler whilst the gauge indicated 10lb. pressure, and the boiler was rather above the working level with water. He had removed the nuts off the bolts, and had given a chisel one blow with the hammer to break the joint of red lead, when the valve left its seating rather sharply—in fact, too sharp for the engineer, as it left him a reminder which he will never forget. As to careless attendants to steam boilers, I have known cases where schoolboys, and in one case a woman, have been left in charge for a considerable time, the men who should have been firing having been away elsewhere, and all the instructions that the tyro has received was to throw on more coals when the finger on the gauge should leave a given number. How about the consequences should the water have got too low? These are sufficient illustrations to show any right-minded person that there is a necessity for some measures to be taken such as were sought for in the bill just rejected by Parliament. Parents might as well provide their children with loaded firearms to play with in the public thoroughfares as allow such persons as the above to have hundreds of lives in their unsafe keeping.—Yours, &c., J. R. W.

Oldbury, April 24.

QUERIES AND REPLIES.

Safe Load on Bolts, &c.—Will any reader give me (1) a table or formula for the safe load on bolts, from ¼in. to 2in. inclusive; (2) a table for the safe load on ordinary gas tubes, when used say for deep well pump rods; (3) a simple formula for working out the power of a compound pumping engine (direct acting), having only the steam pressure at h.p. cylinder given, no indicator diagrams.—J. L.

Answer.—(1) In reply to "J. L.," for a formula for the safe load on bolts from ¼in. to 2in. diameter, inclusive, I give the following for wrought-iron bolts with triangular threads, which gives the safe working strength, and is good for diameters much greater than 2in.

Let d = diameter of bolt in sixteenths of an inch.

W = safe working load in lbs. Then $6{\cdot}514\, d^{2{\cdot}1} = W$. Or, in order to adapt it to the common, or Briggs' system of logarithms, for facility of computation: $2{\cdot}1 \log d + {\cdot}813848 = \log W$.

(2) Ordinary gas tubes are not fit to use as pump rods for deep wells; they are too fragile to stand for any length of time the rough usage of deep well lifts, and their coupling threads are too fine to resist oxidation and the action of diluted acids, which are almost always present in water pumped from the earth.

(3) The power of a compound engine cannot be worked out from having given the steam pressure only at the h.p. cylinder, as "J. L." requests; but it may be computed from the following data, when the steam is supposed to be acting on both pistons during their advance and return strokes, or that the pumping engine is a double-acting one.

$$P\,a\,S\,\frac{l}{L}\left(1 + \log\frac{L}{l} + \log\frac{A}{a}\right) - p\,A\,S = \text{foot pounds per minute} = \text{work, and}$$

$$\frac{\text{foot pounds per minute}}{33{,}000} = \text{h.p. effect.}$$

The $\log\frac{L}{l}$ and $\log\frac{A}{a}$ are the Napierian.

Where P = Initial absolute pressure of the steam per square inch on h.p. piston.

p = Absolute back pressure of steam per square inch, opposing the advance of the l.p. piston, whether by uncondensed steam or atmosphere.

a = Area of the h.p. piston in square inches.

A = Area of the l.p. piston in square inches.

l = Length in feet traversed by the h.p. piston before the steam is cut off.

L = Length of stroke of each piston in feet.

S = Speed of each piston in feet per minute.

If the engine be a condensing one, p may be about 3½lb. or 4lb.; if non-condensing, p may be about 16½lb. or 17lb.—W. A.

Sight-feed Lubricator.—I have now in my charge a sight-feed lubricator connected to the main steam pipe, which, instead of sending the lubricant in the cylinder drop by drop, as it ought to do, breaks the lubricant in *bits*, and fills up in the glass. I have tried several ways to ascertain the cause of this, but have repeatedly failed.—J. P.

Answer.—In reply to "J. P.'s" complaint of his lubricator breaking the oil in bits, I may say that I had some experience of the same sort, and on trying several remedies found that the small delivery tube at bottom of glass was too small and had too sharp a point, causing the oil to string and fall over and stick to the glass, instead of forming a bulb or ball. By adding a little solder to top of tube, thereby giving the oil a broader seat, I found it cured the fault. I assume that the delivery outlets are all right.—B. O. H.

Portable and Traction Engines.—Can any reader inform me whether traction and portable engines are manufactured in any of the following countries: Norway, Sweden, Denmark, Holland, Italy, Switzerland, Mexico, Canada, or in any of the States of South America, or anywhere in Australasia? Or can anyone inform me whether there is any modern geography, directory, or other book published which would give the desired information?—W. A.

Splicing Ropes.—Will any reader kindly inform me what are the most modern methods of splicing ropes for working on pulleys, and do those methods labour under any disadvantages?—R. L. F.

Drag Links of Paddle Engines.—A dimension sketch and description would be of value to the undersigned; also please say whether the link should not lie freely on the pins, like the coupling rod of a locomotive, instead of having brasses so tightened up as to make it immovable, and oblige—Shiny Boots.

Twiner Spindles.—How many twiner mule spindles are reckoned to the horse power?—Inquirer.

TO CORRESPONDENTS.

J. D. C.—The book is published at 6s., and can be obtained from this office.

W.—Write the Secretary of the Institute of Mechanical Engineers.

W. Y.—$\frac{22}{7}$ is near enough, except for very fine calculations.

X.—You will find the drawing in our issue of December 9th.

Chili.—See paper read before the Institute of Naval Architects.

MISCELLANEA.

The American Society of Mechanical Engineers. The seventeenth meeting of this society will be held at Nashville, Ten., from May 8th to 11th. A large number of papers have been prepared for reading.

Cathedral Lighting.—Bristol Cathedral is to be lighted by electricity. It will be used for the first time at the special evening service on June 8th, which is to be held in celebration of the completion of the western towers.

Professor Williamson.—Professor W. C. Williamson, F.R.S., of Manchester, has been elected one of the eight foreign botanical members of the Royal Swedish Academy of Sciences, in succession to the late Dr. Asa Gray.

The Nicaragua Canal.—The Nicaragua Canal surveys are progressing very favourably. Advices up to March 23 indicate that most of the party are in good health, and that the question of labour supply will be a very much less serious one than at Panama.

Large Kimberley Diamond.—The Kimberley papers announce the recent discovery of an exceedingly large diamond—434 carats—on the property of the De Beers Mining Company. The stone is said to be a perfect octahedron of a deep yellow colour, and without a flaw, and its value is estimated at £3,000. In size it is sufficient to cover the palm of the hand with the fingers half drawn up.

The Law Courts.—It appears that the roof of one of the Law Courts has been in a dangerous condition, and on inspection it was found that there had been a shrinkage of one of the beams which was used in building the roof. Iron supports were at once fixed, and business was resumed in the court on the 13th inst. The examination has since been proceeded with in the other courts, but up to the present no cause for further apprehension has been discovered.

Boiler Explosion.—On Saturday morning last a boiler explosion occurred at Messrs. Bradley's Capponfields blast furnaces, near Wolverhampton. One of the feed pumps, it appears, gave way, and the water ran low in the boilers, and during the process of refilling one of the boilers exploded. It was completely overturned. Although a large number of workmen were following their employment at the time, none of them were injured. Much damage was done to the works, and a stoppage for some time was occasioned.

The Panama Canal.—Writing to the *Scientific American*, Mr. A. P. Howard, of Boston, says: "As our papers do not often publish anything but unfavourable information regarding the Panama Canal, it may surprise your readers to be told that on Washington's birthday there was an opening of the Gatun section, and steamers proceeded from tide water to a point beyond Gatun, a distance of eleven miles; and by the end of this month the canal will be navigable for 15 miles—to Bohio—for vessels of 1,000 tons burden. The excavating has gone on very rapidly of late, the excavation for the first half of February being 384,521 cubic metres, while the usual amount for a whole month has heretofore averaged about 332,000. The cut for the Chagres river is well under way, some 1,800,000 cubic metres of excavation having been made on this part of the work alone. The American Contracting and Dredging Company are pushing their part of the work very rapidly, and between January 15th and February 15th contributed over 390,000 cubic metres of excavation to the year's work."

The Indus.—The River Indus has for some years past been showing a tendency to encroach in the direction of the North-Western Railway, some 25 miles below Sukkur; and its right bank having now approached within a mile of the railway, preparations are now being made in advance so as to have everything ready for a retreat, should it be deemed advisable to lay the rails further inland in the event of the river proving abnormally aggressive next flood season. Hitherto the rate of advance of the river westwards, at the point threatened, has been from half to three quarters of a mile per annum.

North German Lloyd's Steamship Company.—The report of the North German Lloyd's Steamship Company, of Bremen, for last year shows that the net profits were £65,750 less than for 1886, which is attributed to the loss of the Oder, valued in the books at £69,900. The dividend declared is at the rate of 5 per cent, against 7 per cent for 1886. The mail services showed a loss of £230,108, which was not completely offset by the Government subsidies, amounting to £220,000, the net loss to the company on this account being apparently £10,108. If, however, a portion of the writing-off to depreciation and repairs accounts be added, it appears that the mail lines have shown a loss of £87,663.

A New Alloy.—Messrs. Vivian and Sons, Swansea (says the *Engineer and Iron Trades Advertiser*), are introducing a new alloy, which they have styled Ferro bronze, said to be suitable for forgings, rolling, bearings, &c. It is claimed for the new metal that with it can be produced bearings of a hardness, density, and strength equal to compressed steel. All kinds of forgings can be made from it, and on account of its cheapness, strength, and resistance to salt water, it is strongly recommended by the makers for propellers for ocean-going steamers. The metal, which has been subjected to some very severe tests, has been highly approved of by experts, and its introduction is being watched with much interest.

Bricklaying in Frosty Weather.—Mr. Mitchell, British Consul-General at Christiania, referring to a previous report of his on the practice of Norwegian builders to work in the coldest weather, says, in a communication published in the *Board of Trade Journal:* "As a striking confirmation of the durability of work done under such circumstances, I have the honour to report that five courses of a house-wall laid on the 10th of March in 1¾deg. Fahrenheit had to be pulled down on the 12th and 13th, owing to a mistake made by the contractor, and that the mortar, when attacked with crowbars, proved to be harder than the bricks, the fractures having in many cases run across the bricks instead of following the mortar joints."

Nelson's Victory.—After the work of repair upon the old Victory, at Portsmouth, had been suspended for nine weeks, it was resumed on Friday morning, the estimate having in the meantime been approved. For a distance of 12ft. from the keel on both sides the bottom planking is of elm, and this is found to be in as sound a condition as when first fitted, the leakage having been caused by the decay of the caulking, and not through the rotting of the wood. From this point upwards to the sill of the lower ports the planking is oak, most of which has been removed, while the top sides are of fir, which was placed in position when the ship was last docked for repairs. It is now proposed to plank the sides of the ship throughout with hard wood, at a cost for material of £3,300 and £6,790 for labour. The work will extend over three months.

Bridging the Hudson.—A bill to bridge the Hudson river and connect New York city with New Jersey has been introduced in the New York Legislature by Judge Greene, of New Jersey. The New York terminus of the bridge is to be between 10th and 181st Streets, the exact location to be determined by a commission appointed by the Governor for this and other purposes. The proposed bridge has but one pier in the river, with spans of not less than 1,300ft. each. No portion of the bridge is to be less than 130ft. above high water, and a space of 500ft. on each span shall be 136ft. above high water. The pier is to be lighted from sunset to sunrise, and be provided with a fog horn. No company is to be incorporated by the passage of this bill, but the commissioners to be appointed shall give two weeks' notice in the public press of the opening of subscription books.—*Engineering News.*

Colliery Explosion at Workington.—News of the terrible colliery explosion which occurred last week near Workington, Cumberland, by which at least 30 lives have been lost, comes as a great blow to everyone connected with the mining industry. The disaster was really the sequel to a misadventure that had occurred earlier in the day. A blasting operation had released a gas "blower," which immediately ignited, and set that part of the workings on fire, and in order to confine the fire to that portion of the mine it was decided to build a wall across, and between 30 and 40 men were engaged in the task. It was while this work was proceeding that an explosion occurred which caused the death of 30 persons, as above stated, or nearly everyone in the mine. On Saturday the work of flooding the mine was continued, in the hope of extinguishing the fire, and there is not the remotest expectation of any of the men, 17 in number, still left in the pit being alive. An explorer states that in a long experience he has never known a fiercer explosion, the havoc created being most remarkable.

SELECTED PATENTS.

APPLICATIONS FOR LETTERS PATENT.

April 13th.

5474 Hoists, A. Newsome, Leeds.
5485 Apparatus for Heating Water for Manufacturing Purposes, A. Jackson, F. Wear, and G. Wear, Halifax.
5496 Furnaces, J. Williamson, Manchester.
5504 Vertical Steam Boilers, T. F. Passman and J. F. Wake, Middlesbrough.
5512 Propellers, O. E. Pohl, Liverpool.
5513 Steam Cylinders and Valves, O. E. Pohl, Liverpool.
5514 Car Couplings, H. Hadden and G. Weldon, London.
5519 Pulleys, W. H. Blessley, Middlesbrough-on-Tees.
5520 Inlaying One Metal in Another, G. Smith, St. Luke's.
5522 Telephonic Apparatus, A. H. G. Segnitz, of the firm of Rösing Brothers and Co., London. (E. Brand, Brazil.)
5525 Wind Motor, W. H. Hall, London.
5526 Propeller, W. H. Hall, London.
5527 Supplying Furnace Fires with Moistened Air, R. Le Las and A. Rob n, London.
5528 Voltaic Batteries, E. Hermite, E. J. Paterson, and C. F. Cooper, London.
5531 Electric Lighting Apparatus, J. G. Statter, London.

April 14th.

5 533 Air Propellers, P. Scott, Manchester.
5541 Screwed Wire, W. H. Dorman, Stafford.
5556 Locomotive Engines, J. W. Smith, London.
5557 Locomotive Engines, J. W. Smith, London.
5558 Torpedo Boats, B. A. Collins, Middlesex.
5560 Steam Boilers, T. Ellwell, London.
5564 Miners' Lamps, C. Wolf and H. Friemann, London.—[Complete Specification.]
5571 Setting Saws, J. Innes, Liverpool. (J. C. Ballew, United States.)
5581 Motive-power Engines, Steam and Gas, G. Delanne, London.
5582 Exhaust Pipes, A. E. Schurr, London. (E. Swinerd, Brazil.)
5584 Paddle-wheel, W. P. Bain, London.
5586 Supports for Electric Incandescent Lamps, H. H. Lake, London. (C. Grivolas, France.)—[Complete Specification.]

April 16th.

5596 Steam Engines, J. Maxwell, Glasgow.
5603 Securing Fish-plates, S. Boxall, London.
5604 Taps, E. Frost and G. Houghton, Sheffield.
5605 Blocking Machine, B. R. Bond, London.
5606 Ball Castors, J. Seyburn, London.
5609 Spring Motor, F. A. Richardson, London.
5626 Springs, H. Woodruff, London.
5627 Utilisation of Exhaust Steam, J. D. Carmichael, London. (R. Petrini, Italy.)
5628 Gas Engines, A. E. Tavernier and E. Casper, London.
5632 Motor Engines, R Humes, London.
5633 Nut Locks, J. H. Piper, London.
5640 Indicating Electricity, H. Edmunds, London.

April 17th.

5661 Parallel Vices, A. Kuchen, Birmingham.
5663 Valves, W. Koss, jun., Glasgow.
5665 Blast Furnaces, W. Evans, London.
5670 Heating Feed Supply of Boilers, J. Rankine, North Shields.
5681 Switches for Electrical Purposes, C. S. Snell, Cornwall.
5708 Dynamo-Electric Machines, J. Lea and C. Juliad, London.
5710 Double Ball Valve, W. E. Mitchell, London.
5715 Belting, P. Jensen, London. (C. A. Shieren and F. B. Brock, United States.)
5717 Moulds for Casting Metals, P. F. Dillon and J. J. Doyle, London.
5719 Hot-air Motors, C. Wells and C. Weber, Middlesex.
5720 Brake for Railway Vehicles, T. Cowburn, F. Tentschert, and A. C. Bonsall, London.—[Complete Specification.]
5724 Motor Engines Worked by Petroleum, C. D. Abel, London. (The Gas Motoren Fabrik Deutz, Germany.)
5728 Water Waste Preventers, O. Elphick, London.
5731 Apparatus for Measuring Electric Currents, H. H. Lake, London. (E. Thomson, United States.)—[Complete Specification.]
5732 Measuring Electric Currents, H. H. Lake, London. (E. Thomson, United States.)—[Complete Specification.]
5735 Separating Grease from Steam, H. H. Lake, London. (J. J. Lowden, United States.)—[Complete Specification.]
5736 Spindles, J. Hogg and W. Hogg, London.—[Complete Specification.]
5739 Machines for Rolled Metal Articles, C. E. Gould, London.- [Complete Specification.]

April 18th.

5752 Hydraulic Motors, G. Russell, Motherwell.
5753 Long-distance Telephone, G. Huck, Burnley.
5756 Floats for Valves, W. J. Wilson, London,
5765 Self-registering Lock, J. T. Kenworthy, Manchester.
5774 Motors, W. T. Rowden, Glasgow.
5775 Pumps, J. H. Carruthers, Glasgow.
5782 Electric Arc Lamp, W. C. Mountaiu, Wandsworth.
5783 Electrical Transformers, W. C. Mountain, Wandsworth.
5788 Controlling Supply Feed Water to Boilers, T. Mudd, Liverpool.
5792 Steam Engines, N. Chandler, London.
5797 Paddle-wheel, F. Gibert, London.
5802 Water Guages, G. F. Redfern, Middlesex. (P. Barclay, United States.)
5810 Slide Rest, W. A. K. Gostling, London.

April 19th.

5811 Generation of Electrical Power, R. E. B. Crompton and J. Swinburne, Chelmsford.
5812 Superheating Steam, R. Shackleton, Yorkshire.
5815 Drilling Machines, J. Parkinson, Bradford.
5824 Hoists, W. C. Tyrie, Newcastle-on-Tyne.
5825 Packings for Piston Rods, J. Haythorn, Glasgow.
5829 Removing Impurities from Boilers, W. Fairclough, Manchester.
5830 Traps for Waste-water Outlets, W. R. Harris and E. T. Whitelow, Manchester.
5832 Hoists, W. Lumb and R. H. Holt, Rochdale.
5833 Preventing Propeller Blades from Corrosion, R. Surfleet, North Wheatley.
5840 Motive-power Machine, A. C. Henderson, London.
5849 Pump Buckets, W. Evans, of the firm of Joseph Evans and Sons, London.

NOTICE TO NEWSAGENTS AND SUBSCRIBERS.

Numorous complaints having been made to us by Subscribers of the difficulty they experience in obtaining copies of the *Practical Engineer* in certain districts, we have to state that the Journal can be obtained by any Newsagent through the ordinary trade channels, and no difficulty should therefore exist in obtaining copies by order of any Newsagent.

For the information of the trade, we may state that copies can be obtained from either of our Offices in London or Manchester, or from any of the following wholesale houses.

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&c., &c., &c.

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EDITORIAL NOTICES.

All communications for the Editor of this Journal should be addressed to 6, Victoria Station Approach, Manchester.

Communications intended for insertion in the current week's issue should reach us not later than Tuesday Evening.

We cannot undertake to return rejected manuscripts or drawings unless accompanied by a stamped and directed envelope.

Contributors are requested to write on one side only of the paper. Sketches should be sent on separate sheets.

TO ADVERTISERS.

Advertisements intended for insertion in the current issue should reach us on Wednesday morning at the latest.

Important Notice to Newsagents and Subscribers.

Our Publishing Offices in London are now at 11, PATERNOSTER BUILDINGS, E.C., where the Trade will in future be supplied.

Simultaneously with the above change, our PUBLISHING OFFICES in MANCHESTER have been REMOVED from Grosvenor Chambers, Deansgate, to more commodious and convenient premises at 6, VICTORIA STATION APPROACH, where all communications intended for the Manager or Editor should, in future, be addressed.

THE
PRACTICAL ENGINEER.
MAY 4TH, 1888.

THE MANCHESTER STEAM USERS' ASSOCIATION AND THE COMPULSORY INSPECTION OF BOILERS.

THE annual meeting of the Manchester Steam Users' Association for the Prevention of Steam Boiler Explosions and for the Attainment of Economy in the Application of Steam, a brief report of which appeared in our last issue, calls for more than a passing notice in view of the legislation respecting compulsory boiler inspection which it is generally understood is at present in contemplation. It is no secret that for a long time past the association, or at least some of its principal officials, have been endeavouring to influence members of Parliament and to induce Government to legislate upon the question, with a view to compelling all steam users to have their boilers periodically inspected, and the Boiler Explosions Act, 1882, was the result of their endeavours, this bill being introduced in the House of Commons by the late Mr. Hugh Mason, who was at that time president of the association. This Act provides for an investigation into the cause of every boiler explosion, whether attended by loss of life or not; and although so far as we know no punishment has hitherto followed the inquiries which have been made under the Act, statistics undoubtedly show that loss of life from boiler explosions has greatly diminished since the Act came into force. About the adequacy of competent periodical inspection as a means of preventing boiler explosions there will probably not be two opinions amongst boiler experts, but great difference of opinion undoubtedly exists amongst steam users respecting the advisability of arming the Board of Trade or any other authority with arbitrary powers to enforce boiler inspection, many large users of steam power maintaining, as shown by the account of the meeting of the Oldham Chamber of Commerce, reported in *The Practical Engineer* for February 3rd, 1888, that the powers already conferred upon the Board of Trade by the Act passed in 1882, above referred to, if fully used, are amply sufficient to act as a safeguard against accidents, and to punish carelessness on the part of those owners of boilers who do not take reasonable precautions to guard against accident.

The Association, although one of the smallest in point of numbers, is, we believe, the oldest of the Boiler Inspecting Companies, which have done so much for boiler engineering in this country during the last quarter of a century. It has under its supervision close upon 5,000 steam boilers, and its members number 1,674. Hence an expression of opinion on the proposed legislation respecting the supervision of steam boilers from a body of *bonâ-fide* steam users such as are included in the Association, if only the meeting at which the resolutions were submitted and carried were at all a representative and unanimous one, or attended by any considerable number of members, must necessarily carry with it considerable weight; and any government contemplating legislation on this question might well appeal to the views of such a body in favour of any legislative proposals it might desire to make on lines which would apparently be acceptable to them. It is, therefore, interesting to note the tenour of the resolutions adopted, but it is still more important to know whether these were really a *bonâ-fide* expression of the views of the great bulk of the steam users forming the Association, or simply a few cut-and-dried resolutions drawn up, say by the secretary or chief engineer, or other official, and merely placed in the hands of selected members to move and support. It will readily be understood that it is possible for so much apathy and indifference to exist amongst the great body of the members forming the Association that a mere handful of members, drummed up for the purpose, might in this way be enabled to pass sweeping resolutions, which would go forth to the world as a genuine expression of the views of steam users generally.

The resolution proposed by Mr. Henry Lee, and seconded by Mr. S. Rigby—both members, be it noted, of the Executive Committee—was to the effect "That this meeting desires to express its increasing confidence in the principle of competent periodical inspection as a means of preventing boiler explosions, with their attendant loss of life, and therefore requests the president and committee of the Association to persevere in their endeavour to secure the introduction of a suitable measure in Parliament that shall bring every boiler in the United Kingdom under competent periodical inspection, but at the same time urges that such inspection should not be carried out by the Board of Trade, but by lay institutions."

As we have already said, there will probably be little difference of opinion respecting the first part of the resolution affirming the adequacy of inspection as a means of preventing explosions, but we very much doubt whether the latter part of the resolution, which requests the president and committee to "persevere" in their endeavours to obtain an act of Parliament compelling steam users throughout the kingdom to have their boilers inspected periodically, will meet with such ready acceptance by steam users generally, or even by the great bulk of the members of the Association, only a very small fraction of whom could possibly have been present at the above meeting; for it will be observed that this meeting of the Association, numbering nearly 1,700 members, was held not in the Town Hall, or other public building where a large meeting could be held, but at the offices of the Association, Mount Street, Manchester, which do not appear capable of accommodating a very large number of persons. If, therefore, the resolution approving of the committee's endeavours to bring about compulsory inspection, moved by two members of the committee, were passed by say only a couple of dozen or perhaps a couple of score members, including the members of the committee, all told, the affair appears to us to be too much after the style of the Tooley Street tailors to render such a resolution of much value as a representation of the views even of the Manchester Steam Users' Association.

It should be further noted that even amongst the small number of members which could possibly have been present at a meeting held in the Association's offices, there was far from being absolute unanimity, as the contrary view was urged by more than one member, who deprecated Government interference, and trusted the committee would do all they could to avoid useless irritation being caused to the owners of works. Thus it will be seen this resolution—which will, doubtless, be referred to in future in the event of a bill being introduced into Parliament—is shorn of much of its importance when the circumstances are considered under which it was adopted, and we submit it cannot be really regarded as a reliable expression of the opinion of the members comprising the Steam Users' Association.

Mr. Lee, in his speech moving the resolution, referred to the fact of the Oldham Chamber of Commerce having voted against the principle of compulsory inspection, but considered the chambers of commerce generally were in favour of further legislation. The fact should not be lost sight of, however, that there are in Oldham and district probably more steam boilers than in any other district of equal area in the world, and the Oldham Chamber is composed perhaps more largely of users of steam power than any other chamber in the United Kingdom; hence an expression of opinion from such a body, whose resolution was adopted with only one dissentient, may possibly be of more real value and significance as an index of the views of steam users generally than a resolution passed by a meeting consisting of a mere handful of members posing as *the* Steam Users' Association. Be that as it may, it is a question requiring serious consideration whether legislation has not gone sufficiently far in the way of compulsion; and, considering the comparatively trifling loss of life which now takes place annually, when the enormous number of boilers in use in this country is considered, it is quite possible that such a price may have to be paid by steam users in the way of having to submit to harassing interference with their business and trade for the little further reduction in the annual number of explosions which could be made, as to render the game not worth the candle. Many, indeed, who are entitled to speak with authority on this question are of opinion that nothing further is necessary than to make steam users fully aware of their responsibilities; and seeing that the great bulk, or at least the majority, of steam users voluntarily take all necessary precautions by putting their boilers under competent inspection, they consider that if the careless or negligent ones, whose recklessness or indifference may lead to disaster, were only duly punished, as a warning to others, the loss of life from boiler explosions would soon be reduced to a minimum, or at least to almost as low a figure as could possibly be secured by making the inspection of all boilers compulsory, and that needless interference with any trade or business, which in the present critical state of many trades might be of vital importance, would thus be avoided.

GAS ENGINE TEST.

We have received a report of a test of a "Griffin" patent double-acting horizontal gas engine, conducted by Mr. Andrew Jamieson, Professor of Engineering, Glasgow and West of Scotland Technical College. The tests extended over nine hours, at three different periods, and were directed, first, to obtain simultaneously the brake and indicated horse power, and secondly, the electrical horse power. The result showed that the practical efficiency of the engine was 15 per cent, and the absolute efficiency, or taking the indicated horse power, 19 per cent. It will thus be seen that 4 per cent of the total available energy, or 21 per cent of the indicated horse power, was required to turn the engine itself. The results are certainly remarkable. The report deals very fully with the method of making the trials. We may add that the "Griffin" gas engine is made by Messrs. Dick, Kerr, and Co., 101, Leadenhall Street, London.

LITERATURE.

Granites, and our Granite Industries. By Geo. F. Harris, F.G.S. London: Crosby Lockwood and Son.

This very readable and practical little book is intended for the assistance of commercial and professional men who are interested in the granite industry, although at the same time it will, no doubt, interest the geologist as well. The structure of granite is very ably described in the second chapter, and the next deals with the origin of the stone. In chapters four to eight are described the various well-known quarries, and the kind of stone obtained therefrom, in England, Channel Islands, Scotland, and Ireland respectively, while the remaining part of the book relates to the subjects of joints and blasting, and the manipulation, cutting, dressing, and polishing of the stone. The remarks on these heads are in every sense of word practical, and prove the author to be well versed in his subject.

Electric Lighting of the Brussels Exhibition.—The illumination of the Brussels Exhibition is divided into three sections, viz., the lighting of the buildings by electricity, the lighting of the fountains by the same means, and the lighting of the gardens by gas. For the last-named purpose 20,000 gas jets will be employed.

MOULDING AND CASTING OF CYLINDERS.—I.

By a Practical Man.

It is generally admitted amongst moulders that no class of work gives more trouble and annoyance than the casting of cylinders, not only from the intricacies which often accompany the job, but the general nature of it. From the time it comes into the foundry until cast and passed safely through the turner's hands, no one can with any surety say that his work is good. As a moulder of many years' experience in this class of work, I will endeavour to lay before my readers the experience I have gained on this subject, which may be of some service to those who have to do with this class of work. I hope to be able to make myself intelligible, without the aid of drawings, to practical moulders, for whose benefit this is written. The natural beginning of this subject, and the one I shall start with, is the ramming of the job, after which will be considered other matters as they develop while working out the mould. The ramming of the job is of the utmost importance in securing a good casting, and the moulder who thoroughly understands how to ram his work has gained the mastery of one of the chief points which help to make an intelligent and successful moulder. There is not certainly so much danger in ramming a dry sand mould as there is in the ramming of a green sand one, but still too much hard ramming will not do for dry sand, of which cylinder moulds are generally made, because if there is a flat surface on the mould, and the sand is rammed too hard, ten chances to one but that the casting will have blisters upon it; if this were a green sand casting, it would most certainly be scabbed. I have found that the surest and safest rule to go by is to ram as if it were a green sand job.

As regards the pricking or venting, it is not absolutely necessary that this should be done, except there be projections, or, as they are commonly known to the moulder, "pockets," as the drying of the mould makes the sand so porous that the air passes quite freely from it without the aid of direct vents. Indeed, I have more faith in sprigging than venting in dry sand; but the use of sprigs is very often overdone; there is no necessity for sprigging, unless it be to protect the mould from the rush of the metal, or some part that may have started with the drawing of the pattern.

Finishing the Mould.—This is a point on which I need say very little, as it is only by practice that anyone can be able to finish a mould successfully; hence I will only throw out a few hints in passing. As soon as the pattern is drawn—and I hardly need say that the utmost care should be taken to secure a good draw, as there is nothing like the first impression, *i.e.*, if the pattern be a good one—care should be taken to sleak down the joint, and to see that every part that may have started is put back into its proper place, so that, when it comes to the "closing" of the mould, every part may be fair and free from crushing. Some moulders seem to think that, because it is a dry sand mould, any amount of water showered on itbefore finishing is beneficial; but such is not the case. No doubt water is absolutely essential in making a strong mould; but if itis used indiscriminately, so as to cause the mould to be glazed, the consequence will be that the blackwash will not adhere to it, and, as a natural result, there is every likelihood that the skin will be covered with blisters in the drying; therefore it is better to avoid the free use of water; but if it is desired to strengthen any weak part, a little put on after it is finished will do good. Care should also be taken not to finish the mould, or polish it, until the grain of the sand becomes imperceptible, for to do so is lost labour, besides making it difficult for the blackwash to adhere to the sand. As it is not my intention to treat in detail every minor point relative to or connected with the making of the mould, believing that such would be of little value to the practical man, and of little interest to the uninitiated, I consider it unnecessary to treat of the working of the blackwash further than to say that the drier the mould is before being blackwashed the better; and, likewise, if it is allowed sufficient time to stiffen before being sleaked, it will materially assist in getting a good skin on the casting. The reason of this is obvious, from the fact that the drier the mould is it will take the blackwash the better, and, if this be adhered to, the results are sure to be satisfactory.

Cores.—The sand with which the cores are made has so much to do with the core in its entirety, that it is perhaps as well that I should give in detail some information on this point. The first mixture that I was acquainted with for the cores of small cylinders, such as donkey engines, or steam-crane cylinders, was a mixture of equal parts of rock sand, green sand, and dry sand, with a little coaldust added. These were all well mixed together and passed through a fine riddle or sieve, then moistened with clay water, and afterwards pounded or tramped with the feet, and riddled again, after which it was ready for use. I have also often made them with sea sand, commonly known as "parting sand," mixed with a little pinmeal or gum to strengthen it. But experience has taught me that none of these mixtures are commendable. I have obtained results more satisfactory from the following simple mixture: One part of dry horsedung loam, and three parts rock sand. If the loam be fresh and not burned, add a little common dry sand, or "black sand" as it is commonly called; and should the loam contain no horsedung, a very good substitute may be found in sawdust, but care must be taken not to put too much sawdust in it, as it will destroy the cohesion of the sand. After it is properly mixed, put it through a riddle with ¼in. meshes, then moisten it with clean water. As there is sufficient cohesion in the sand and loam, there is no need of clay water; indeed, clay water would endanger the casting, as there can be no doubt whatever that the weaker it is possible to work the sand the more porous the cores will be, and, consequently, the air will pass more freely from them. This is a core sand that can be used for the smallest or largest cylinders made in dry sand, and I can with the utmost confidence recommend it.

Core-making.—The core-maker should be careful to avoid ramming too hard, as any core so treated is difficult to vent, and likewise difficult for the dresser to clean from the casting. He must also pay particular attention to have a good clear vent, as this is the all-important factor in core-making. He must also be careful before blackwashing to see that the surface of the core is entirely free from glaze, as there is nothing more dangerous in creating blisters, that is, if the core, or any part of it, be lying horizontally in the mould, such as in the case of the steam-chest, or part of the steam-port. This blistering is of more frequent occurrence in locomotive cylinders, from the fact of there being more surface in the ports when cast on end. There are many who hold that this fault is due to the chaplets. No doubt a chaplet which is not clean, and is corroded with rust, will invariably have a bad effect; yet, after a careful and experimental study of the subject, I believe by far the greater dangers arise from a hard and glazed core. The following is an example: I was once engaged in making a class of cylinders which had a crown core having from two to four feet of surface. As this was a class of cylinders which required no chaplets, it may perhaps astonish my readers that I was very much annoyed with blisters. Various things were suggested and tried without success. Ultimately I tried carding or roughening of the surface, and it had the desired effect, and put an end to the annoyance. From this it must be obvious that the chaplets have very little to do with it. All chaplets that may not be clean should be oiled or burned, but oiling is generally more handy, and I believe the better plan of the two.

(To be continued.)

THE WHITWORTH ENGINEERING LABORATORY, OWENS COLLEGE.

On the evening of Wednesday, April 25th, the members of the Owens College Engineering Society, with a number of the staff of Messrs. Mather and Platt, Salford, paid a visit to the above laboratory.

The laboratory is fully equipped with all the ordinary types of machine tools, and a very complete testing machine and various other experimental apparatus, but undoubtedly the most interesting and novel points in the laboratory are exhibited in the arrangements of the experimental engines. These engines may be said to fairly bristle with ideas, and reflect the highest credit on Dr. Osborne Reynolds, and on the constructors, Messrs. Mather and Platt.

In these engines an attempt has been made to make the various operations and changes which the steam undergoes measurable to a degree never previously attained. The steam is supplied by a boiler of the usual locomotive type, the safety valves of which are loaded to 200lb. The gases, after emerging from the smoke tubes, pass through a horizontal feed-water heater or economiser, situated below the barrel of the boiler. The arrangement for actuating the tube scrapers is novel, and consists of a rotating horizontal shaft, on which is cut a double crossing screw, such as may be seen on some corkscrews. The rotation of the shaft causes a slieve with a float (which follows the thread) to move backwards and forwards, and so operates the scrapers. Complete arrangements are made for working with a forced draught. The engines are three in number, and are of the vertical inverted type, the small cylinder being 5in. diameter and 10in. stroke; the intermediate, 8in. diameter and 10in. stroke; and the large cylinder, 12in. diameter and 15in. stroke.

The cylinders can be worked either jacketed or unjacketed, and complete arrangements are made for ensuring the flow of steam through the jackets, for draining the jackets, and for measuring the rate of condensation in them. The steam ports are short, but of ample area, all the diagrams showing well-sustained steam lines. The valves are all arranged with an adjustable cut-off, of the type known as Meyer's. The crank shaft of each cylinder is separate, and the cylinders are placed far enough apart to allow of a flywheel, a brake, and a coupling between each. The engines may either be worked uncoupled or coupled, at any desired angle. By running the engines uncoupled at different speeds, any desired cylinder ratio may be obtained.

The brakes are perhaps the most noticeable of the many interesting features presented by these engines. The resistance is caused by vanes, which rotate with the crank shaft moving through water, the motion of which is opposed by vanes fixed in the brake casing, to which is attached the brake lever. It is found that the resistance of the brake varies according to the amount of water passing through it. Advantage is taken of this fact to make the brake absolutely automatic and self-adjusting, by making the rise and fall of the brake lever to regulate the amount of water passing through. Thus, suppose the weight to have just been applied, and the lever in its lowest position, the full quantity of water will then be passing through the brake, and the resistance consequently greatest. This will cause the lever and weight to be lifted, so reducing the supply of water until the resistance of the brake just balances the weight on the lever, which then remains steady, so ensuring that greatest desideratum in engine trials, a perfectly constant resistance. This ingenious arrangement, which is due to Dr. Reynolds, is worthy the careful attention of steam engineers, especially in view of the brake controversy which was raised after the Newcastle engine trials last year.

The low-pressure cylinder has a surface condenser attached, with a vertical air pump. The hot well and condensation water discharge are both measurable.

A separate indicator is fixed to each end of each cylinder. These indicators, which are of the Crosby type, gave beautifully steady diagrams at the speeds, from 200 to 300 revolutions per minute, at which the engines were running.

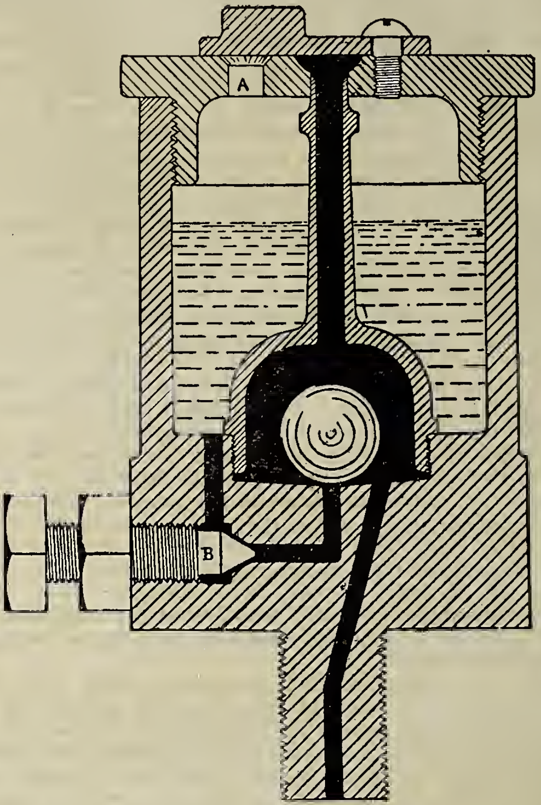
Dr. Reynolds had kindly arranged to have the engines running, and, to illustrate the operation of the arrangements, during the evening made a rough experiment illustrating the great increase of efficiency by jacketing. Of course, the cylinders being small and the ratio of surface to volume consequently high, the effect of the efficient jacketing is greater than is met with in ordinary practice, and also, generally, it may be said that the conclusions arrived at with these engines are not directly applicable to ordinary working conditions. Still, it is evident that the complete equipment and design of these engines gives opportunities for experiment on the many unsolved problems of the steam engine, which must be of the highest value to the young engineer, and which will doubtless result in increased and valuable knowledge on many unsettled points.

Those present afterwards partook of substantial refreshments, at the invitation of Dr. Reynolds, to whom a hearty vote of thanks was passed, and the remainder of the evening was spent in that social and convivial manner which is characteristic of engineering institutions in general.

THRELFALL'S PATENT AUTOMATIC ADJUSTABLE FEED LUBRICATOR.

THIS invention consists of an oil reservoir, with an inner chamber containing a brass ball-valve with its concave seating. Leading from the oil reservoir to the inner chamber is a passage terminating in the centre of the ball-valve seating, from which another passage exits leading through the shank of the lubricator. The pipe running from the valve chamber through the lid is for the purpose of admitting air, and for flushing the parts to be lubricated with oil if necessary. The aperture, A, is for filling the lubricator with oil, both this and the pipe mouth being protected by a hinged slide to prevent dust, ashes, or other injurious substances getting into the lubricator. The valve, B, regulates the supply of oil passing from the reservoir into the valve chamber. When the locomotive is in motion the ball rolls loosely on its seating, thus admitting oil, which passes unimpeded to the parts to be lubricated. It will be seen, therefore, that the lubricator is automatic in its action, stopping and starting with the machinery, as, when the locomotive is at a standstill, the ball rolls firmly on the centre of its concave seating, thereby stopping the supply of oil, and so preventing waste.

These lubricators can be applied to locomotive motion bars, piston rods, valve spindles, engine and tender axle bearings, cylinders, and steam chests. For the two latter they are exceptionally good, as they will lubricate either with steam on or off. They also work extremely well on cylinders of steam hammers, the vibration when striking a blow causing the ball to rise from its seat, thereby allowing the oil to flow, as is the case with the locomotive in its rolling action. When at rest the ball falls on the aperture in the centre of the concave seat and stops the supply of oil.



These lubricators have been fixed on all the steam hammers in the smithy and forge of the North-Eastern Railway Works at Gateshead, and they are still working satisfactorily after over two years' trial, giving no trouble, and effecting a great saving of oil.

The ordinary way of lubricating steam hammers is by means of a grease cock fixed on the top of the cylinder, and when the hammer is at rest the attendant opens the cock and pours in oil or melted tallow, as much as half a pint at a time, the dose being generally repeated three times a day. Immediately the steam is turned on, and at the first stroke of the hammer, the whole of the oil or tallow of course passes out through the exhaust, the cylinder deriving little benefit. This cannot be the case with Threlfall's lubricator, the feed being regular, and each drop of oil doing its work efficiently.

Many locomotives on the North-Eastern Railway are now working with these lubricators on the motion bars, valve spindles, cylinders, steam chests, &c., some having had them on for over three years, and they are still working satisfactorily. They also give satisfaction on stationary, marine, and tramcar engines.

The lubricators are manufactured by Messrs. W. H. Bailey and Co., Salford, Manchester.

ENGINEERS AND TECHNICAL EDUCATION.

A MEETING of the Manchester Association of Engineers was held on Saturday evening, at the Grand Hotel, the president, Mr. S. Dixon, in the chair. The discussion opened on the 14th inst. upon the subject of what should be the technical education of engineers was resumed.—Mr. Boswell urged that every man engaged in any particular trade should be a perfect master of that branch. The old rule of thumb must give way to science, and muscle to brain.—Mr. Nasmith said he did not believe that technical education would do as much as some people held that it would. The great difficulty in their way, the difficulty which stood in the way of all educational reformers, was that they had to deal with a mass of heterogeneous material of the nature and capabilities of which they were absolutely ignorant. All that technical education could do was to render more intelligent the working classes with whom they had to deal, but the importance of the preparatory training at school must not by any means be lost sight of, for it was the real groundwork of the after education. Mr. Hans Rehnold held that the principal point to be borne in mind was that technical education required to be divided into three divisions—technical education for the workman, for the foreman, and for the manager and designer. If this were conceded, a good deal of difficulty would be removed.—Mr. J. Ashbury said that in the training of young men there was a fear lest they should be crammed too much and not educated in the truest sense of the word—that was with a view to draw out and develop the mind of the student. The teachers of our colleges and schools should be faithful to their trust, and single out to the best of their judgment those boys who showed an intelligent and marked bias for following any particular pursuit, so that their parents and those in charge of them, being informed of it, should enable them to follow the course of study relating to that pursuit to the utmost. If we wanted to maintain our supremacy, we must divide our work in the matter of training into greater variety and more special subjects than was the case now. It was, he believed, impossible in the present day for a youth to become an expert in more than one branch.—The Chairman, having replied upon the discussion, moved the following resolution: "That this meeting hereby resolves to appoint a committee to draw up a syllabus of the different branches of study for youths engaged in the engineering workshops, indicating at the same time the relative importance of those branches, and that such syllabus be published with the authority of the association at a nominal price."—The resolution was seconded and passed.

THE EDUCATION OF ENGINEERS IN PRUSSIA.

Young men desiring to obtain positions as engineers or architects under the Prussian Government must first graduate at a gymnasium, and then at the age of eighteen to twenty years begin their technical study. Those desiring to be civil engineers or architects commence with a two years' course at one of the technical high schools of Berlin, Hanover, or Aachen, and then undergo a preliminary examination in science, mathematics, and building construction. Then follows a second two years' course, after which comes the first examination. The successful candidate becomes a Regierungs Baufuehrer (assistant engineer or architect on public works). He then spends a year on some Government work without salary, followed by two years as assistent to a Government engineer or architect. The second examination then takes place, and comprises a design worked out at home, and another produced under the eye of the examiner without the assistance of works of reference. The candidate is then appointed Regierungs Baumeister (Government engineer). Intending mechanical engineers have a somewhat different course of study. They commence with a year's apprenticeship in an engineer's works; then follow in succession two years at the high school, the preliminary examination, two more years of study, the first examination, two years of practice, one year for passing the second examination—eight years in all. At the end of this probation the candidate is engaged on temporary work at a salary of 10s. to 12s. a day. Five years later he may expect a permanent post.—*Engineering.*

THE AGE OF CHEAPNESS.

It is a remarkable fact that the country which calls for the largest quantity of costly and thoroughly trustworthy English tools is the place of origin of the veriest rubbish with which the British markets are flooded. The largest firm of edgetool-makers in the world has at present its books filled with orders from German houses for the finest articles it makes in chisels, gauges, and nearly every class of carpenters' and carvers' appliances. And it is from Germany we get the cheap scissors which snap ta the bows, the meat chopper at 5½d., the mincer at 4½d., the trowel and fork at 6½d. the pair, the screwdrivers at 1d. a-piece, chisels at 5½d., sardine-openers at 3½d., and lemon-squeezers at 4½d. Side by side with these are placed British goods, usually about twice the price. But there is no mistaking the quality; even a novice can discern the superiority of the English article. Yet the ordinary customer, who professes to know a bit of hardware when he sees it, is tempted by the cheaper article, grumbles when it breaks down in his hand, and then buys again with a similar result. If he had purchased a reliable English-made article to start with, he would in all probability have been using the single tool comparatively uninjured during the time he had worked out two, three, or four of the low-priced things. But buyers are not wise—the best of them are tempted by bargains. And thus it comes about that the cheap and nasty nick-nacks of Germany still hold the field, even in England.—*The Engineer.*

HOW TO BECOME A LOCOMOTIVE ENGINEER.

A writer in the *American Machinist* makes the following characteristic remarks on the above subject:—

"Engineers are not made to order. No doubt you have read 'How to Become an Actor,' or how to become this or that, but you wish to be an engineer. Well, first go into the shops of some railroad company and serve an apprenticeship at the machinist trade. You will be after knowledge, and willing to work hard. You will be paid about seventy cents per day in money, the remainder in knowledge. If you are an apt pupil, and work earnestly, your pay will gradually be raised, so that when you begin the third year you will be drawing the princely salary of ninety cents per day. You will still be drawing part of your compensation in knowledge, however.

"After you have paid for boarding and clothes, you can spend the remainder of your salary in buying books that treat on mechanics, wherein you can read many things that you ought to know, if you could only understand them, and some other things that you ought never know. Well, after serving the apprenticeship, you can go out on the road to fire extra, and when your turn comes, in a week, or in two years, as the case may be, you will get a regular engine to fire. Now the soft snap begins, if it has not begun already. You will only be required to keep the engine clean, hot, keep off the rust in bad weather, fill oil cans, clean fires, carry sawdust, draw supplies, put out and take in signals, put in a little bit of packing in piston or valve stem box, when the engineer has some pressing business up street and tells you to do it, if you happen around (you always happen around in such cases). You will do all this and various other jobs; also be told occasionally that you are no good, and cannot fire a cook stove. However, if you have perseverance, and do your duty manfully for four or five years, you may eventually get killed or promoted. Become an engineer? Oh, no; not yet. You are not an engineer yet. You have one year ahead of you wherein you will have to tax your judgment and skill to the utmost limit in order to get through safely. With breakdowns, narrow escapes, and blunders, &c., you will put in the most memorable year of your life learning to become a locomotive engineer.

"If you pull through all right, and run on for two or three years, meanwhile read up on matters bearing directly and indirectly on the calling you follow, acquire habits of thought and observation, you may eventually become a first-class locomotive engineer. But if you have not a natural liking and inclination for the business and hard work, you better stay away; there are too many 'middling' engineers now."

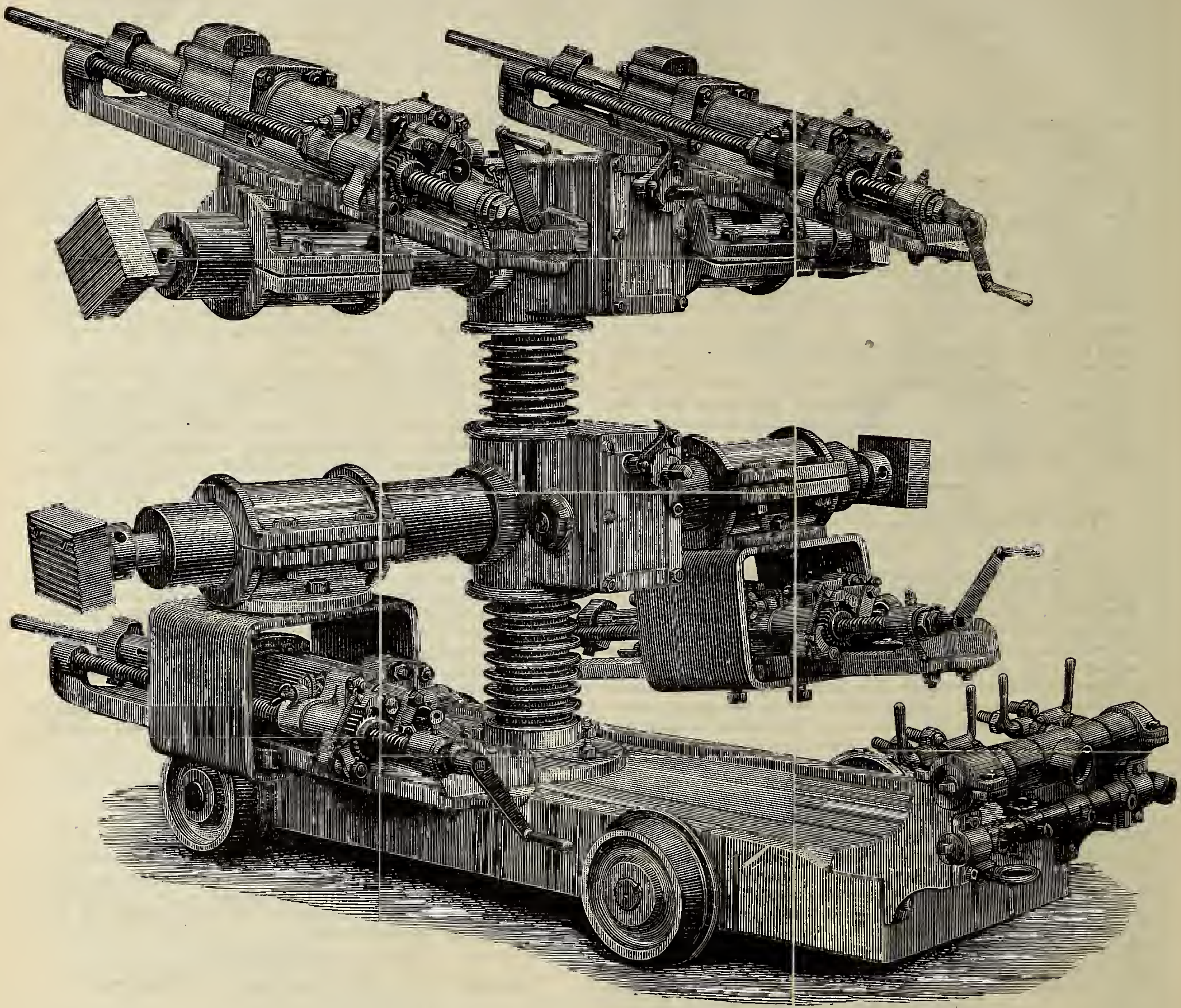
HOW PETROLEUM WAS FORMED.

The theory is held by Prof. Mendeleef, of Russia, that petroleum is produced by water which penetrates the earth's crust and comes in contact with glowing carbides of metals, especially of iron. The water is decomposed into its constituent gases, the oxygen uniting with the iron, while the hydrogen takes up the carbon and ascends to a higher region, where part of it is condensed into mineral oil, and part remains as natural gas, to escape wherever and whenever it can find an outlet. If this assumption is correct, and a sufficient store of metallic carbides is contained in the earth's interior, petroleum may continue to be formed almost indefinitely and yield a supply of fuel long after the coal has become exhausted. Prof. Mendeleef supports his views by producing artificial petroleum in a manner similar to that by which he believes the natural product is made.—*Engineer and Iron Trades Advertiser.*

Semi-dry Pile.—A new dry or semi-dry pile has recently been invented by M. Messerole, which is made with common soap dissolved in boiling water, to which has been added a small quantity of caustic soda or caustic potash. This mixture is poured while hot in a cell, in which has previously been placed a large carbon rod, and a plate of amalgamated zinc. On cooling the mixture forms a paste, which does not easily evaporate.

THE "BEAUMONT" ROCK DRILL.

CONSTRUCTED BY MESSRS. JOSEPH FOSTER AND SONS, SOHO FOUNDRY, PRESTON.



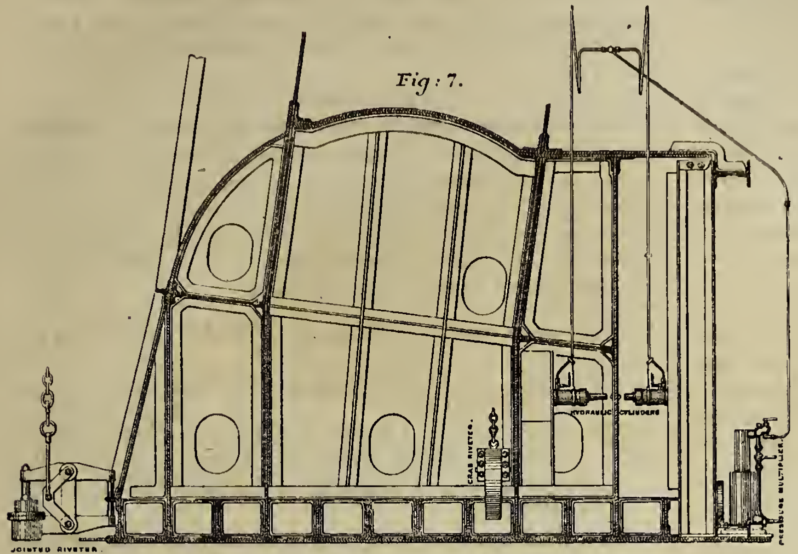
The "Beaumont" percussive rock drill has been proved by use to be a most effective machine, and in the form shown by our engraving is suitable for railway tunnels and other headings where the greatest speed is required. The working parts are reduced to a minimum in number, and these being made of the best material, very few repairs are found to be necessary even after long use. The speed of boring, of course, depends upon the rapidity and weight of the blows given, and in this machine, with a pressure of 50lb. steam or compressed air, 400 to 500 blows per minute are given, the speed depending on the size of the drill used. The stroke is very short. The drill is mounted on a rod attached to a piston, which is operated by a piston valve, and the piston itself effects both the feeding and the twisting of the drill. It has been found impossible to make satisfactory progress with a drill fed by the miner himself, and hence the value of a simple and reliable automatic feed arrangement is apparent. In this machine the rate of feed is not fixed, but the drill advances exactly as the depth of the hole increases, no matter how variable the nature of the rock may be. The rotation of the drill is also automatic, and the bit strikes a new face of the rock at every stroke of the piston. To effect this, the cylinder is made with an opening at the top, in which the ends of two levers lie in contact with the piston; the other ends of these levers are attached to rods running parallel to the axis of the cylinder. One rod commands two pawls, working into a ratchet wheel on the end of the feeding screw, and the other actuates a pawl, gearing into a wheel on the end of a square spindle that enters the hollowed portion of the piston. On each stroke of the piston, by the above means, the drill is both advanced and rotated. This device can be thrown out of gear and the drill advanced by hand, if desired. The drill, when started, requires no attention until the cylinder has advanced to the end of the screw, when it is wound back, and longer drill-bits are fixed to bore the hole to the required depth.

Our engraving shows a group of four drills, mounted on a heavy vertical standard, fixed to a suitable wheeled carriage, on one end of which are placed the various connections for leading the steam or compressed air to the drills. The centre pillar, carrying the cross arms, is constructed to enable the drills to be worked in any direction. The cross arms are fitted with strong clawed screws, for packing against the sides of the heading, and the drills are secured to them by means of universal clamps. The makers are Messrs. Joseph Foster and Sons, Soho Foundry, Preston.

HYDRAULIC APPLIANCES AT THE FORTH BRIDGE WORKS.—III.

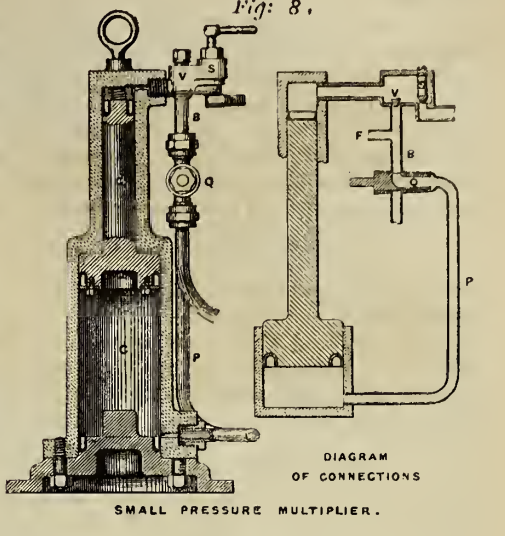
(*Continued from page* 186.)

Fig: 7.



METHOD OF RIVETING SKEWBACKS.

Fig: 8.



SMALL PRESSURE MULTIPLIER.

Fig. 7 is a section of one of two skewbacks or main junctions over the caisson piers, showing the position in which these cylinders were employed. The two cylinders are connected by small copper piping sufficiently flexible to bend easily, and provided with suitable hinged joints to one tee piece, from the third arm of which is led a copper pipe of larger diameter to the pressure multiplier, which is large enough to keep two or three pairs of cylinders in operation. Fig. 8 is a section of this machine; C is a brass casing or cylinder, having two diameters, the squares of which are in inverse ratio to the pressure on the two ends of the ram.

The plunger has a piston upon its end of the diameter of the lower part of the cylinder.

Referring to the diagram of the connections, Fig. 8, F is the flexible hose bringing water at 1,000lb. per square inch to the under side of the conical valve, V, as well as leading through the branch, B, to the cock, Q, which is an ordinary plug cock, communicating through the pipe, P, with the base of that part of the cylinder having the larger diameter. From the space on the upper side of the conical valve V, there are two branches, one leading into the end of the cylinder having the smaller diameter, the other controlled by the screw-down valve, S, to the small riveting rams. The cock, Q, being turned to exhaust, and the pressure at 1,000lb. filling (after lifting the conical valve, V) the smaller cylinder, the water below the larger piston is forced out, and the ram brought to the commencement of its stroke. When a rivet is to be struck, the screw-down valve, S, is opened, filling the piping and small rams with water, at 1,000lb. per square inch. The rivet is squeezed as far as the pressure of 1,000lb. on an area of 12 square inches will squeeze it, when it is necessary to put on the higher pressure of 3 tons. This is done by turning the cock, Q, which allows the water at 1,000lb. pressure to enter the larger cylinder, thereby increasing the pressure in C′; thus shutting the conical valve against the water at the lower pressure and preventing it from leaking back into the mains, while at the same time the rivet gets the necessary load to properly compress it. For riveting the vertical and diagonal tubes machines of special design are employed, similar in principle to the one already described in connection with the bed-plates, but differing from it to suit the form and position of the tubes on which they work.

LESSONS IN MECHANICAL DRAWING.—XVI.

By Prof. A. MacLay, B.Sc., C.E.

LOCI (*continued*): CURVES TO EQUATIONS.

We come now to the second class of curves (according to our division in Lesson XII., p. 76), which are of interest to engineers.

In curves drawn to experimental data some kind of proportionality may or may not exist between the pair of co-ordinate distances for any one point and those of any other; but in those now to be considered the co-ordinate distances are in some fixed proportion throughout, the relation being expressed in the form of an equation. While therefore in the one case a particular statement is necessary for fixing

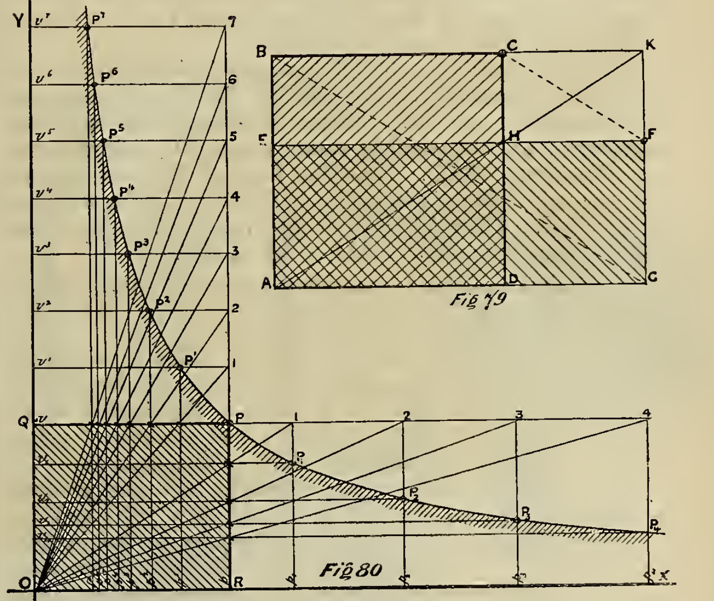


Fig 79

Fig 80

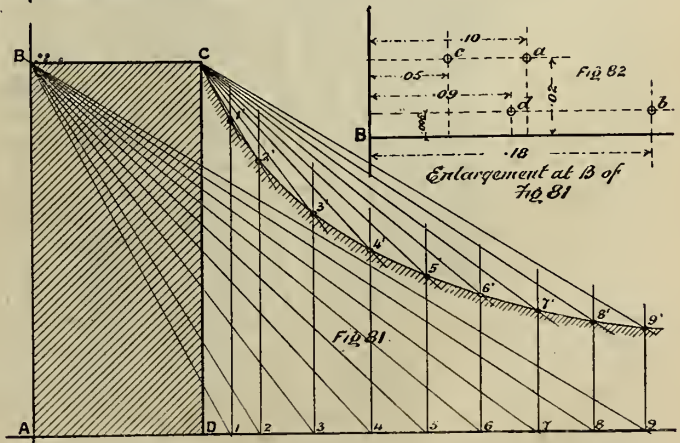


Fig 82

Enlargement at B of Fig 81

Fig 81

each individual point in the curve, in the other, one general statement—the equation—includes every point. The equation is reduced to figures, and from these the curve is drawn precisely in the same manner as has been shown in the last two lessons.

Let us begin with a simple case. Take for example Boyle's law of the relation of pressures and volumes in gases. The statement of this law is that "the volume of a portion of a gas varies inversely as the pressure," or in other words, that the one increases in the same ratio or proportion that the other decreases: in mathematical language, that the product of pressure and volume is a constant quantity. These are algebraically expressed thus:

$$p \propto \frac{1}{v}; \ pv = c \text{ or } p = \frac{c}{v}$$

where p represents the pressure, v the volume, and c a constant number for a certain quantity of gas at a particular temperature, and the curve representing this equation is called an "isothermal." If we first assign any convenient number for c, and next assume a series of values for p, we can then get the corresponding values for v, or *vice versa.*

$$\text{Thus suppose } c = 1000, \text{ then } p = \frac{1000}{v}$$

Assumed values of v	10	20	30	40	50	60	70	80	90	100
Corresponding v'lues of p...	100	50	33·3	25	20	16·6	14·2	12·5	11·1	10

A curve can now be drawn to these figures on the squared paper referred to in last lesson, using say 1 unit of length per unit of pressure and of volume.

The same result may be obtained geometrically by drawing equivalent rectangles. Let ABCD, fig. 79, be any rectangle on AD as base. Suppose we require an equivalent rectangle, *i.e.*, one equal in area, on base AG, complete the parallelogram ABKG. Draw the diagonal AK, and through H, the point where it intersects CD, draw EHF parallel to AG or BK. Then AEFG is the equivalent rectangle on base AG 18 or, AB × AD = AE × AG.

[For by Euc. I., 43, the complements of the parallelograms, which are about the diagonal of any parallelogram, are equal. Thus EBCH = DHFG. Add to each AEHD, then ABCD = AEFG.]

Thus if C be any point on the curve of which $pv = c$ is the equation, F is a second point on that curve. Notice that the same point F can be found by drawing CF parallel to BG. In fig. 80 this principle is applied to find a series of points on the curve representing any value of the equation. OX and OY are the axes of the diagram. Let the pressure ordinates p, p_1, p_2, &c., be measured from OX, and the volumes v, v_1, v_2, &c., from OY. Suppose, as before, that $c = 1000$, if $p = 50$ units, then $v = 20$ units. Set these off to any convenient scale, as OQ, OR, and draw the rectangle OP. Produce the lines QP, RP indefinitely, and take a number of points, 1, 2, 3, &c., on each. Draw lines joining these points with O, and through their intersections with RP and QP draw horizontals and verticals to intersect verticals and horizontals respectively through the points 1, 2, 3, &c., at the points P_1, P_2, P_3, &c., and P^1, P^2, P^3, &c. Through these latter the required curve is to be drawn.

Or again, suppose that a certain quantity of air at a given pressure is to be expanded according to this law, a modification of the above diagram gives the curve of expansion. In fig. 81 let the rectangle ABCD represent a quantity of air at pressure p. Draw a series of verticals at 1, 2, 3, 4, &c., and join B_1, B_2, B_3, &c. Then through C draw $C1^1$ parallel to B_1, $C2^1$ to B_2, $C3^1$ to B_3, and so on, and draw the required curve through 1^1, 2^1, 3^1, &c.

Let us pass now to the case of curves to equations of a more complex form. Take for example the general equation representing the law of variation of pressures and volumes in the expansion of gases under different conditions. This is written,

$$pv^i = c.$$

Where p represents the pressure at any time during the expansion, v is the corresponding volume, and i is an index depending on the conditions.

To obtain the arithmetical values for plotting the curve, assume as before, some value for the constant c and a series of varying valves for p or v. For calculation the equation takes the form

$$\log p + i \log v = \log c,$$

from which a table can be made for any number of ordinates. For example, $pv^{\frac{10}{9}} = c$ is the equation to the "adiabatic" curve for the expansion of steam, the index value $i = \frac{10}{9}$ here referring to the condition of no transmission of heat either from the cylinder to the steam, or from the steam to the cylinder. To draw this curve then, let $c = 1000$, and let p be successively equal to 10, 15, 20, &c.

Thus since $pv^{\frac{10}{9}} = c$, then $v^{\frac{10}{9}} = \frac{c}{p}$ and $\frac{10}{9} \log v = \log \left(\frac{c}{p}\right)$ or $\log v = \frac{9}{10} \log \left(\frac{c}{p}\right)$. When $p = 10$, then $\log v = \frac{9}{10} \log \left(\frac{1000}{10}\right) = \frac{9}{10} \times 2 = 1{\cdot}8$, and from a table of logarithms we get $v = 63{\cdot}096$. Again, when $p_, = 15$, $\log v_, = \frac{9}{10} \log \left(\frac{1000}{15}\right) = \frac{9}{10} \log 66{\cdot}6 = \frac{9}{10} (1{\cdot}8234742) = 1{\cdot}6411269 = \log 43{\cdot}765$, $\therefore v_, = 43{\cdot}765$.

In a similar manner the figures in the following table can be obtained—

Pressures in lbs. per sq. in...	10	15	20	30	40	50	60	80	100
Volumes in cub. feet	63·096	43·765	33·815	23·403	16·90	13·095	12·538	9·71	7·94

Then, having obtained the figures necessary for drawing the curve, plot it to scale, or trace it out on squared paper.

In this connection it may be permissible to describe a method of drawing the above curve to the equation $pv^{\frac{10}{9}} = c$ as well as the locus to the other equation, which is most often used in connection with steam diagrams, viz., the curve corresponding to the equation $pv^{\frac{17}{16}} = c$, generally known as that of (the pressures and volumes of) saturated steam, or as the "saturation curve."

This method has been devised by Mr. McFarlane Gray to obtain the curves by a simple construction, and save the trouble of calculation or of plotting from tables on the one hand, and on the other to avoid the incorrectness which arises from drawing them as shown in fig. 81. Gray's correction consist in using some point other than B, in fig. 81, from which to draw the diagonal lines there shown, and in this way make the curve drawn a closer approximation to that which represents the actual conditions represented in the equation. The positions of the points so used are shown in fig. 82, and explained in

TABLE XI.

Name of Curve	"Adiabatic"				"Saturation"			
Equation	$pv^{\frac{10}{9}} = c$				$pv^{\frac{17}{16}} = c$			
Grade of Expansion ......(fold)	1 to 5		6 to 20		1 to 5		6 to 20	
Direction of Measurement......	hor.	vert.	hor.	vert.	hor.	vert.	hor.	vert.
Points	*a*	*a*	*b*	*b*	*c*	*c*	*d*	*d*
Distance to right of AB in fig. 81, in parts of AC......	$\frac{1}{10}$	...	$\frac{18}{100}$	...	$\frac{1}{20}$	...	$\frac{9}{100}$	...
Distance above BC in parts of AB	...	$\frac{1}{50}$	...	$\frac{6}{1000}$	...	$\frac{1}{50}$	..	$\frac{6}{1000}$

EXERCISES.

Ex. 70.—The piston of an air-tight vessel is partially withdrawn, so that 216 cubic inches of air at the ordinary atmospheric pressure (14.7lb. per square inch) occupies 1 cubic foot. Draw the "isothermal" curve.

Ex. 71.—An engine is using steam at 21lb. pressure per square inch above the atmosphere; the length of the stroke is 3ft., and the steam is cut off* at one-third of the stroke. Set out on a diagram the approximate steam pressure on one side of the piston throughout the stroke, and mark the pressures at the second and third feet of the stroke.

---

* In fig. 81 C corresponds to the point of cut off, while the rectangle ABCD represents the quantity of steam used, *i.e.*, the volume swept through by the piston before the valve is closed, plus the clearance at the end of the cylinder; but in the above questions the latter is for simplicity left out of account.

Ex. 72.—An engine works with steam of 60lb. pressure; the steam is cut off at one-fifth stroke. Draw an indicator diagram, marking the steam pressure at one or more points of the stroke.

Ex. 73.—The initial pressure of steam in a cylinder, whose stroke is 5ft. 4in., is 45lb., and expansion commences when 2ft. 3in. have been performed. Find the pressure at the end of the stroke.

Ex. 74.—Let the initial pressure and the grade of expansion be such as they might be in a triple expansion engine, say steam at 150lb. pressure per square inch, expanded fifteen times, but suppose that the expansion takes place in one cylinder. Show for comparison, in one diagram, the curves of pressures and volumes to each of the three equations, $pv = c$, $pv^{\frac{10}{9}} = c$, and $pv^{\frac{17}{16}} = c$, adopting the method of fig. 81, and using the points $b + d$ as given in Table XI., and shown in fig. 82.

HYDRAULIC POWER IN LONDON.

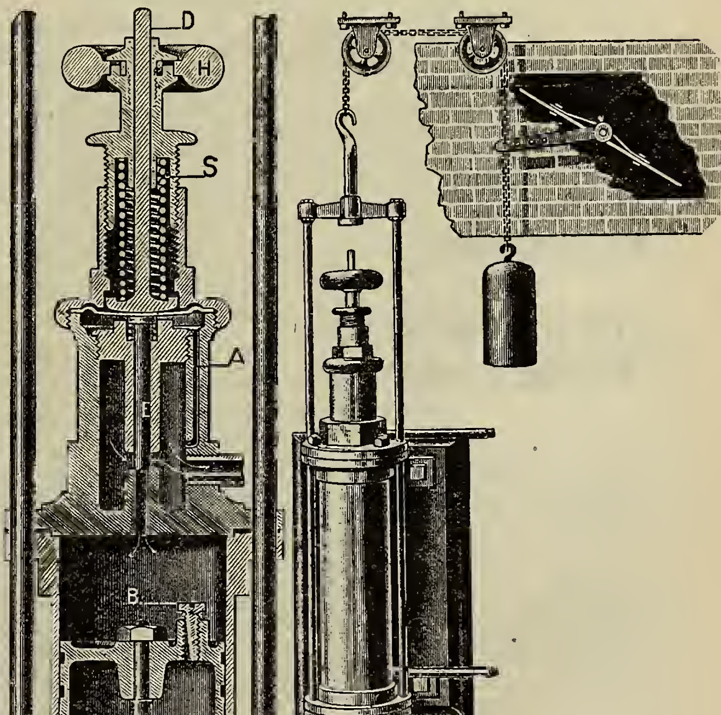
At the ordinary meeting of the Institution of Civil Engineers, on Tuesday, the 24th of April, the President, Mr. Bruce, being in the chair, the Paper read was on "The Distribution of Hydraulic Power in London," by Mr. Edward Bayzand Ellington, M.Inst. C.E.

The author observed that water power was no new force, but that, as formerly understood, it was limited in its application to systems of mechanism suitable for the low pressures found in Nature. The effects obtained by the use of high pressure were so different in degree from all previous experience that a new name was needed, and had been found in the term "Hydraulic Power." Bramah's genius produced the hydraulic press, and he clearly foresaw the future development and great capabilities of his system; but it was reserved for Lord Armstrong to work out and superintend the intricate details that had to be developed before the system could be made fully serviceable. The public supply of hydraulic power in London constituted the latest development of this system. The hydraulic power was supplied through mains charged by pumping at a pressure of 700lb. per square inch. The first and largest pumping station had been erected on a site known as Falcon Wharf, about 200 yards east of Blackfriars Bridge. The engine-house at present contained four sets of pumping engines, each set being capable of exerting 200 indicated h.p. The engines were vertical-compound, of a type comprising the advantages of a three-throw pump with direct connection between the pump plungers and the steam pistons. Each set of engines would deliver 240 gallons of water per minute into the accumulators, at 750lb. pressure per square inch, at a piston speed of 200ft. per minute. This was the normal speed of working, but when required they could be worked at 250ft. per minute, the maximum delivery being 300 gallons per minute. The condensing water was obtained from storage tanks over the engine-house, and was returned by circulating pumps to one or other of those tanks. The water delivered into the mains was maintained all the year round at temperatures of between 60° and 85°. The boilers were of the double-flued Lancashire type, and were made of steel. All were fitted with Vicars' mechanical stokers. At the back of the boilers was a Green's economiser, consisting of ninety-six tubes. The economiser and the stoker gear and worm were driven by a Brotherhood three-cylinder hydraulic engine. The reservoir of power consisted of accumulators. The accumulators at the pumping station were two in number, each having a ram 20in. in diameter and of 23ft. stroke. The weight cases were of wrought iron and were filled with iron slag. The total weight of the case and load on each ram was approximately 106 tons, corresponding to a pressure of 750lb. per square inch. The storage tanks formed the roofs for the engine and boiler houses. The water for the power supply was obtained from the river Thames, and was pumped into the tank over the engines. The water passed through the filtering apparatus by gravity into the filtered water tank over the boiler-house, which was 7ft. below the level of the unfiltered water tank. The filters consisted of cast-iron cylinders, and each contained a movable perforated piston and a perforated diaphragm, between which was introduced a quantity of broken sponge; the sponge was compressed by means of hydraulic pressure from the mains. The delivery of power water from the Falcon Wharf pumping station was through four 6in. mains. The most distant point of the mains from the accumulators was at the west end of Victoria Street, and was 5,320 yards, or just over three miles. To provide for all frictional loss in the pipes and valves, the accumulators had been loaded to 750lb., the stated pressure supplied being 700lb. per square inch. The total length of the mains at present laid was nearly 27 miles. The mains were laid in circuit, and there were stop valves at about every 400 yards, so that any such section of main could be isolated. The method employed for detecting leakage was based upon an automatic record of the number of gallons delivered into the mains, and in cases of abnormal increase during the night, if found to arise during the early hours of the morning, the mains were tested. The power water used was invariably registered through meters on the exhaust pipes from the machines, and from the meters passed to the drains. There was a sliding-scale of charges, from 8s. to 2s. per 1,000 gallons, at 700lb. pressure per square inch, designed to meet, as nearly as possible, the variable conditions and requirements of consumers. The more continuous the use, the lower the charges. The scale was intended chiefly for intermittently-acting machinery, and experience had fully proved that these rates were sufficiently low to effect a large saving to the consumer in almost all cases, whether for a large or a small plant. The author believed any idea of supplying power from a central source at rates much below these to be chimerical. The practical efficiency of the hydraulic system might be fixed at from 50 to 60 per cent of the power developed at the central station. No other method of transmission would, to say the least, show a better result; and the general convenience and simplicity of the hydraulic system were such that its use would hardly be affected, even if there were no direct economy in the cost of working.

(To be continued.)

THE CURTIS DAMPER REGULATOR.

In this device (says the *American Machinist*, from whom we obtain the illustrations) the principle of the Curtis pressure regulator has been applied to the movement of a damper in the flue of a steam boiler, so as to obtain uniformity of boiler pressure.



It is said that these damper regulators can be made to open and close the damper with a variation of boiler pressure inside of 1lb. The full view shows it as attached to a damper, and the sectional view shows the operating parts. Steam is brought in a

¼in. pipe from the boiler to the chamber surrounding the valve, E. This pressure is also carried through the side pipe, A, to the diaphragm. By turning down on the handle, H, the spring, S, is compressed, loading the diaphragm with any given weight, thus holding the valve, E, to its seat. When the boiler pressure in the valve chamber rises high enough to lift this load the valve opens, say $\frac{1}{100}$ of an inch, admitting the steam to the top of the piston, P, pushing it down to the bottom of its stroke, overhauling the chain, and closing the damper. The improvement consists in extending the stem, D, of the follower (which rests on the phosphor bronze diaphragm) up through the handle to such a length that the yoke rests on it when the damper is sufficiently closed, thus forcing the valve, E, to its seat, and cutting off the flow of steam into the piston chamber. The piston starting back relieves the pressure on the spindle, D, permitting the valve, E, to open again, providing just the needful pressure in the cylinder to hold the damper closed until the boiler pressure falling, say one-half pound, has no longer power to open the valve, and the weight opens the damper. The condensation in the chamber over the piston passes through the adjusting screw, B, being carried away by a small drip pipe into the ashpit. Another improvement consists in making the piston, P, quite long, a loose fit, and putting in water grooves, which make a tight water packing to a perfectly free piston. It is claimed that this arrangement, while very sensitive, is particularly valuable in places where dirt, ashes, &c., are likely to clog the operation of ordinary mechanical devices. Taking the steam from the boiler at full pressure, all the power necessary to move the damper under all practical difficulties is available. While so much power is not necessary in the well-kept boiler room, there are many steam boilers that need powerful regulators, as where the dampers become rusted and clogged with dirt.

CORRESPONDENCE.

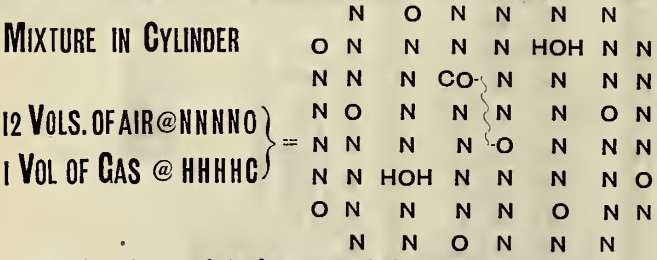
We do not hold ourselves responsible for the opinions of our Correspondents.

THERMO-DYNAMIC ANALYSIS OF THE GAS ENGINE.

To the Editor of "The Practical Engineer."

Sir,—As your correspondent, Mr. Edward Hawks, promised some further statement this week, I deferred replying to his remarks in yours of the 20th instant, in order to make one answer, if possible, suffice. No further remarks, however, appear, so I will proceed to my reply. First, as to "What possible reason can be shown why a similar agitation and admixture *just* before ignition should not be equally effective ?"

On the occasion of my reading the paper before the Manchester Association, I presented a diagram graphically illustrating this point, a copy of which I now enclose. In it is shown the probable dispersion of the atoms of a charge of twelve parts of air and one of gas, and on reference to it I think the necessity for *agitation after ignition* will be readily apparent to all ; for as one atom of carbon requires two atoms of oxygen to complete combustion, and as no agitation before ignition can cause the collection or coupling of the atoms of oxygen in the mixture, but rather the opposite effect, it follows that agitation before ignition is quite ineffectual in developing inflammation. It is only by agitation after ignition that the molecule of carbonic oxide (CO) formed by ignition can be moved in the mass of the surrounding inert gases until it meets with a second atom of oxgen (O) to form carbonic acid (CO_2). Such seems to me the most favourable aspect in which we can look upon the process. If, on the other hand, we were to imagine the process to be single and direct—that is to say, that carbonic acid was formed immediately without the intermediate condition of carbonic oxide—then how doubly necessary, and yet how slowly, would inflammation take place, depending, as it would do, upon the chance simultaneous juxtaposition of the atoms : indeed we can hardly imagine such a coincidence of juxtaposition as that of the two atoms of oxygen when we remember the antipathy of any atom of a gas for any other atom of its own species, the very element upon which a gas depends for its existence.



In reply to the second point in your correspondent's remarks, I think it must be admitted to be irrelevant, for, though acknowledging his statement to be perfectly true, without regard to the context, and admitting that under certain *peculiar* conditions water can be brought to a temperature of about 220° Fah. without boiling, we cannot admit that those peculiar conditions obtain in a gas engine ; and therefore, as regards the question under the title of my paper, the statement is not true, and I will not occupy the valuable space of your columns by discussing bi-issues. At the same time, I must thank your correspondent for asking me to make more clear a point under his first query I had evidently not sufficiently explained.—I am, sir, yours truly,

Albert Road, Levenshulme, **Herbert Guthrie.**
Near Manchester, April 28th' 1888.

THE STEAM ENGINES AND BOILERS BILL.

To the Editor of "The Practical Engineer."

Sir,—I have read your article last week with considerable interest, and fully agree with you that Parliament took a common-sense view of the matter when they rejected the bill. I listened very attentively to the debate, but the promoters of the measure entirely failed to make out a case why such a law was necessary. Sir Michael Hicks-Beach clearly showed that out of the 57 explosions during the year not one would be touched by the proposed bill. Ostensibly the object of the bill was to prevent explosions, but its real reason was to introduce certificates, in order that, at the time of a strike like that on the Midland Railway, other persons (not possessing certificates) could not be employed to drive engines. It is a well-known fact that some of the best engine-drivers to-day are not scholars, and to put them through a stiff theoretical examination would be to remove them from their positions. To overcome that difficulty it was intended to exempt them from examination. But if an examination is so necessary as those in favour of the bill say, why should exceptions be made ? The Boiler Bill of 1888 should more properly be called a "bill to assist strikes." But even if it had been read a second time, its promoters would have failed in their object, as a clause had been carefully prepared, a draft copy of which was shown to me, which it was intended to add to the bill in committeee, suspending the operation of the act during such disputes or strikes. If anything can be done to prevent explosions, by all means let it be done ; but, under the cover of a so-called boiler bill, do not let us be saddled with a weapon to assist in strikes. I cannot believe that Parliament will ever pass a bill with such an object. On the other hand, let us hope that railway servants will never again allow themselves to be misled into unnecessary strikes, which end in disaster and ruin to the men.—Yours faithfully,

Clement E. Stretton, C.E.,
Associated Society of Enginemen and Firemen.
Leicester, April 28th, 1888.

To the Editor of "The Practical Engineer."

Sir,—Please allow me space for a few remarks on the above bill. In the first place, I think it would prevent more boiler explosions than members give it credit for, as, in my opinion, corrosion and deterioration ought to be put down to ignorance of the attendant. Who should know what is going on about a boiler better than the man who is with it daily, and cleans it, say every four or six weeks ? Such cases as were mentioned in some remarks on "Dry Seasons" would seldom occur if the attendants were competent men. How are we to know the inspector is competent or truthful in his reports ? Not far from here a boiler was enrolled in a well-known insurance company. The hero of the handbag came, put on his gear, went inside the boiler as far as the bridge in the furnace, came out again without going in the flues, though it was considered an entire examination ; but a favourable report was duly received.

Most of the insurance companies sent circulars to the employers of enginemen to do all they could against the bill ; but no doubt, as "Chalkline" says, there are good times coming for good men. At most of the large manufacturing concerns men are in charge of the steam power who can see further through a half-inch steel plate than nine-tenths of the inspectors. It is worth remarking there were only 198 members out of 600 in the House when the bill came on.—Yours, &c.,

Coventry. **Ignorance.**

TALLOW CUPS v. SIGHT-FEED LUBRICATORS.

To the Editor of "The Practical Engineer."

Sir,—In answer to your correspondent, "Lubricant," I may say that I used to be of his way of thinking, but experience has shown me different. There is no doubt in my mind that to thoroughly mix the oil with the steam before it reaches the engine is not only the best, but the only proper way to work. Let "Lubricant" run over in his mind the number of places to which he would have to apply pipes to secure the same result ; say, stop valve, throttle valve (if he has one on), expansion and main valves and piston of high-pressure cylinder, and valves and piston of low-pressure cylinder—all of which he may lubricate by the system I speak of, and I think he will no longer doubt its efficiency and economy. I know cases in which the quantity of oil used on this plan is so small as to appear almost incredible, and certainly leaves no room for further economy. I am here reminded that one of your correspondents tells me that it is not wise to economise oil at the cost of extra friction ; I hardly suppose, sir, that it needed a prophet or a sage to tell us that.—I am, &c., **Corliss Valve.**

Heaton Norris, April 28th, 1888.

HEATED NECKS.

To the Editor of "The Practical Engineer."

Sir,—If "Young Engineer" will only secure the rigid quality of the shaft between bearings, and then see that they have not more pressure than 500lb. per square inch, he will have no heated bearings.—Yours, &c., A. Kay.

April 28th.

To the Editor of "The Practical Engineer."

Sir,—In your issue of the 27th inst. I noticed a letter from one of your correspondents, who is seriously troubled with hot bearings, asking for opinions respecting the same. At the mill where I work I can say that we have been troubled as much as anyone, and tried almost everything we could without getting the desired effect, till at last we got one of Monk and Anderton's positive pouring lubricators, and after the same had been working a short time we found that we had got what we wanted, viz., "a cool neck." I may state that we drive with a belt, and all the pedestals are on an angle, so that the belt is always pulling at the bottom step. The lubricators recommended use very little oil, and I may say that the masters are so well suited with the results obtained that they have put three more on, having now four working altogether, the results being in every sense satisfactory. I would also suggest the advisability of putting a tin cap over the bearing, the same to extend a little over the shafting at each side, to keep the dust out of the necks.—I am, sir, yours, &c.,

April 30, 1888. On the Watch.

ENGINE-KEEPERS' ASSOCIATION.

To the Editor of "The Practical Engineer."

Sir,—Now that the "Steam Engines and Boilers Bill" is dead, I should like to ask the readers of your valuable paper if it is not possible to form an association in England similar to the "Glasgow and West of England Engine-keepers' Association." I refer your readers to your issue of November 25th, 1887, which gives a report of its first general meeting. I find the association not only grants certificates to competent engine-keepers, but delivers lectures and papers on subjects pertaining to the safe and economical working of steam engines and boilers, and in addition the secretary makes it his duty to look out for vacancies, and replies to advertisements for the benefit of members who should happen to be out of work. Should the engine-keepers and stokers express a desire to form such an association, I feel confident they would receive every support from the heads of the large engineering firms throughout the country, as this would not be against capital but in favour of it, and equally advantageous to the employer and employed.—I am, sir, yours truly, Engine-keeper.

April 30th, 1888.

QUERIES AND REPLIES.

Drag Links of Paddle Engines.—A dimension sketch and description would be of value to the undersigned; also please say whether the link should not lie freely on the pins, like the coupling rod of a locomotive, instead of having brasses so tightened up as to make it immovable, and oblige—Shiny Boots.

Answer.—In answer to "Shiny Boots," I herewith send a rough sketch of cranks and connecting rod, or drag link, for the paddle shaft of a steamboat, and may state that the coupling rod of a locomotive engine works under very different conditions to the drag link connecting the two parts of a steamboat paddle shaft. The locomotive coupling rod connects axles together which are at considerable and practically fixed distances apart, and the rods are always practically in the same position, or are parallel to the road or railway bars, whence each of the crank pins on which they bear rotate once within their bearing during each revolution of the crank. The shaft of a paddle-wheel steamer, which, although originally placed in line, may, by the rough action of the sea and consequent straining and distortion of the vessel, have its different parts considerably displaced from the true or intended centre line, and thereby be rendered unworkable, to obviate which the shaft is divided into shorter lengths, and the ends of the several portions connected by cranks, with coupling link between their crank pins. If the centres of the different parts of the shaft are coincident and truly in line, the link will go round with the cranks, without any frictional or rubbing action taking place between the crank pin and its bearing in the link. If, however, the parts of the shaft be out of line with each other, a slight motion of the bearing surface of the link on each crank pin will take place, in one direction during half the revolutions of the crank, and in the opposite direction during the remaining half, the amount of which motion is dependent on the amount of displacement of the shaft centres in comparison with the length of the cranks and their connecting link, which, therefore, ought to be as large as convenience admits of. Either crank may be the driver or driven one, and the link brasses should be cottered to a solid but not tight bearing on the crank pins.—W. A.

[The sketch sent by W. A., which was not dimensioned, reached us too late to be reproduced.—Ed. *P. E.*]

Regulating Engines.—Will some of your readers kindly give me their experience as to the best arrangement for regulating an engine with constantly varying and extreme loads; *i.e.*, whether to apply sensitive governor to throttle or to variable cut-off gear. The particular engine I have in view has slide valve with cut-off plates on back, and boiler pressure of 70lb.—X.Y.Z.

Answer.—The safest and most correct way of regulating an engine is a variable cut-off valve, connected to main governor, and a Knowles supplementary governor. By using the combined governor, however the load or pressure may vary, the supplementary governor will alter the length of the main governor rod so as to keep it in the same plane. In case the main governor should fail, the supplementary governor will keep the engine under control. The sole makers are Messrs. Hick, Hargreaves, and Co. Bolton, where your correspondent will get every information.—W. M.

Portable and Traction Engines.—Can any reader inform me whether traction and portable engines are manufactured in any of the following countries: Norway, Sweden, Denmark, Holland, Italy, Switzerland, Mexico, Canada, or in any of the States of South America, or anywhere in Australasia? Or can anyone inform me whether there is any modern geography, directory, or other book published which would give the desired information?—W. A.

Splicing Ropes.—Will any reader kindly inform me what are the most modern methods of splicing ropes for working on pulleys, and do those methods labour under any disadvantages?—R. L. F.

Twiner Spindles.—How many twiner mule spindles are reckoned to the horse power?—Inquirer.

Expansion Gear.—Who are the makers, and where can I get a description of, Powell's automatic expansion gear?—Learner.

Scaling Shell Forging.—What is the best mode of scaling the interior of a forged shell? It is partially punched in forcing into shape.—Cort.

Sensitised Paper.—Would some reader kindly give me the names of the chemicals and proportions of the solution for coating paper for taking copies of tracings by the same method as printing photos from a negative?—Surface Table.

TO CORRESPONDENTS.

J.—Your communication is not suitable.

X.—The area allotted to the English Commissioners is just over 43,000 square feet; or about one-thirteenth of the whole area of the machinery hall.

Inventor.—Your best course would seem to be to try and get some maker to go shares with you. The idea, if new, can be provisionally protected for a nominal sum until you have made satisfactory arrangements.

N. C.—Holmes' book, price 6s., will suit you as well as any.

J. D.—Communication received, and will appear next week.

Cort.—Greenwood's work on Metallurgy, amongst the cheaper kind, is considered a good book. The best practical information on steel is, of course, contained in the numerous papers that have been read in late years before the different engineering societies. Coke's Chemistry we do not know.

Compound.—As far as can be judged from the diagrams, your engine has about as much load on as it can well do with at the present speed and boiler pressure. Whether the engine can stand an increased boiler pressure or not depends on the strength of the working parts, and of course this can only be judged on inspection. Probably your best plan will be to speed up to say 45 revolutions. An increase of 40 per cent in the load is rather a big one.

MISCELLANEA.

Paris Exhibition.—The United States Congress has passed a resolution accepting France's invitation to participate in the Paris Exhibition of 1889, and has voted 250,000 dollars for this purpose.

Bursting of a Gun.—On Thursday week a gun of a heavy type, which was being tested at the proof butts on Woolwich Marshes, burst, blowing away a portion of the muzzle. It is understood that the weapon was one built upon a new principle, and of a construction totally different from the ordinary service gun.

Speed of Earthquakes.—By taking the hours at which the pendulums of different clocks were stopped by the Charlestown earthquake, Professor Simon Newcomb and Mr. Dutton conclude that the velocity of propagation of the shock was 1,700ft. per second, with a possible error, positive or negative, of 250ft.

Aluminium.—Aluminium is the most generally diffused metal on earth, being found almost invariably in clay, especially in red clay. It is now extracted from clay by a very expensive and tedious process, but it may reasonably be expected that a rapid and cheap process of extraction will some day be discovered, and then farewell to iron mines.

The Panama Canal.—The French Chamber, on Saturday, adopted the Panama Canal Obligations Bill by 313 against 132 votes. A special clause stipulates that the State does not guarantee the bondholders against risks. The deputies were anxious not to incur the responsibility of ruining the enterprise by refusing the authorisation demanded.

Conveying Power by Boreholes.—A novel method of conveying power to mine workings is described in a recent number of the *Colliery Engineer* as being in use at the Shenandoah Mines, Pennsylvania, in which, as the lower level of the Mammoth seam had been, in 1883, nearly worked out, it became advisable to develop new workings. To convey power to these an 8in. hole was drilled from the surface to the seam, a depth of 244 feet, and when finished this hole was lined with a 5⅝in. casing pipe, through which was passed a 1in. steel wire rope, transmitting the power required for hauling purposes below. A second borehole, 6in. in diameter and 118ft. deep, was also put down, and through it was passed two 2in. pipes, to be used as a speaking tube and for a bell wire, to permit of communication between the engine-house and below ground.

The Ribble Navigation.—The bill to authorise the Corporation of Preston to borrow £510,000 to complete the Ribble Navigation works came before a Select Committee of the House of Lords last week. Mr. Bidder, Q.C., stated the case for the promoters, and, referring to the objections which the Local Government Board had taken to the bill, said evidence would be given to show that the Preston Corporation was in a sound financial condition.

Wear of Tyres.—Tyres wear most rapidly just after being turned. The reason for this, as brought forward in recent discussions in the Western Railroad Club, is that the surface of the steel is injured by the heavy cuts used in turning, and rendered less durable. Tyres that are ground instead of turned are claimed to be free from the disadvantages of turned tyres, having a smooth and uninjured surface less affected by wear than the usual rough and torn surface left by turning tools.

Elementary Manual on Steam and the Steam Engine.—Last week we reviewed Professor Jamieson's larger Text Book on Steam and Steam Engines, third edition, and we learn that he will shortly bring out (in time for next session) a strictly elementary manual or introduction to the same, specially suitable for first year students. The publishers, Messrs. Charles Griffin and Co., hope to produce this book, well illustrated, at half the price of the bigger book, so as to suit all mechanics interested in a study of the steam engine.

A Long Engine Run.—A 10 h.p. Westinghouse engine has been running in the works of the Pittsburgh Gaslight Co. for 13 months without the throttle valve being shut, and it is still running. The engine has run continuously at about 500 revolutions per minute, and has made 288,000,000 revolutions in that time. The last public notice of a long run made by a Westinghouse engine was an instance where a certain engine ran eleven months without stopping at a speed of 300 revolutions.

The Manchester Waterworks: Thirlmere Scheme.—No. 1 contract of this scheme, it will be remembered, was originally let to Messrs. Thomas Vernon and Co., and afterwards to Messrs. Morrison and Mason, for £129,972. The new contractors have proceeded very energetically with the work, which is progressing at a rate to complete the contract in about three years. In the three long tunnels, viz., Dunmail Raise, Nab Scar, and Moor Howe, of the respective lengths of 5,165 yards, 1,419 yards, and 3,040 yards, the lengths driven are 1,677 yards, 692 yards, and 975 yards.

The Blackburn Technical School.—The Technical School Committee at Blackburn met on Monday afternoon and adopted the report of Mr. E. C. Robins, the assessor on the designs, submitted by nearly 100 architects in all parts of the kingdom, for the new Technical School, which is to be erected at a cost of £25,000, and the foundation-stone of which will be laid by the Prince of Wales on the 9th inst. The award is as follows: 1, Messrs. Smith, Woodhouse, and Willoughby, 100, King Street, Manchester; 2 (premium, £100), Messrs. J. and C. J. Corbett, 9, Albert Square, Manchester; 3, (premium £50), Messrs. Briggs and Wolstenholme, 1, Richmond Terrace, Blackburn.

Coalmines Regulation.—The Coalmines Regulation Act of last session is now in full working, and the Home Office is almost overwhelmed with work in consequence. It is provided by the Act that persons who have served five years in any mine may be appointed under-managers, and already there have been upwards of 6,000 applications for certificates of qualification for these posts. The Secretary of State has been employing examiners to ascertain the fitness of the applicants, and certificates are now being issued at the rate of several hundred a week. Another duty imposed on the Home Office is giving rise to considerable friction. The Act provides for the framing of rules for the conduct of mines, and requires the Secretary of State's sanction to them. It seems, however, that what satisfies the owners does not please the miners, and numberless inquiries are in consequence to be held all over the mining districts with a view of effecting concessions such as will please both sides.

Underground Electric Tramway for Paris.—The Third Commission of the Municipal Council of Paris has under consideration a project of an underground electric tramway, to connect several of the chief points of this city. The project, due to M. Berlier, has been examined and reported on favourably by the engineers in the service of the municipal authorities. There are to be three lines running from the Place de la Concorde, one to the Bois de Boulogne, another to the Place de la Bastille by way of the great boulevards, and the third to the Porte de Vincennes by way of the Rue de Rivoli. All these lines are to run underground for the whole distance. The tunnel, instead of being constructed of masonry in the usual way, will be formed of a cast iron tube of circular section, and 6m. in diameter. It is proposed to construct these lines without opening the streets at any point. The tunnels, the stations, and the cars are to be lighted by electricity. One great advantage will be the good insulation which it is possible to maintain in an underground line of this character. The estimated cost of the whole length, of a little more than 16 kilometres, is £2,160,000, an average of £129,400 per kilometre.—*Electrical Review.*

SELECTED PATENTS.

APPLICATIONS FOR LETTERS PATENT.

April 20th.

5872 For Motor Engines Operated by Explosive Mixtures, W. P. Theermann, Manchester.
5880 Indicating the Speed of Engines, M. G. Kelso and R. Hill, Glasgow.
5890 Steam Engines, F. P. Hawkins, London.—[Complete Specification.]
5898 Telegraph Apparatus for Communicating between one part of a Navigable Vessel and another, W. Chadburn, Liverpool.
5899 Ships' Engine-room Telegraphs, W. Chadburn, Liverpool.
5900 Mechanical Telegraphs for use in Navigable Vessels, W. Chadburn, Liverpool.
5911 Arrangement of Switches and Motors, M. H. Smith, Middlesex,
5913 Electric Telegraph and Telephone, A. W. Heaviside, Newcastle-on-Tyne—[Complete Specification.]
5914 Hydro-carbon Engines, H. H. Lake, London. (A. Spiel, Germany.)
5915 Steam Engines, W. A. Pitt, London.—[Complete Specification.]
5919 For Mechanism Employed in Strengthening the End Plates of Steam Boilers, J. Cotton, Huddersfield.
5923 Bearing Metal Mixture, H. K. Austin, London.
5928 Driving Belts, C. E. Winterros, London.

April 21st.

5929 Brick Moulding Machines, S. Eddington and J. E. Steevenson Chelmsford.
5932 A Hot Air Chamber, C. J. Henderson, Hawick.
5939 Grinding Machines, G. W. Elliott, Sheffield.
5945 Sawing Machine, J. Hill and I. Hill, Derby.
5951 Trip Gear for Valves, E. Wigzell and J. Pollit, London.
5952 Pumps, A. G. Melhuish, London.
5961 Slide Valves, G. J. C. D'U. Skinner, Middlesex.
5962 Safety Lamps, E. Charles and C. Wells, Middlesex.
5977 Valves, Sir W. Vavasour, Baronet, London.

April 23rd.

5989 Printing Machinery, J. H. Buxton, D. Braithwaite, and M. Smith, Manchester.—[Complete Specification.]
5993 Lock, J. F. H. Van der Hoop, London.
5998 Hand Printing Presses, S. B. McCallum and T. S. McCallum, Plymouth.
6005 Cocks, A. S. Tanner and W. W. Howe, London.
6012 Compositions for Coating Metal Structures, E. F. Wailes and E. J. Dove, London.
6022 Packings for Pistons, J. Bickle, Liverpool.
6031 Imparting Heat to air in connection with Engines, W. P. O'Neill and F. O'Neill, London.
6036 Gas Engines, E. H. Gaze, London.
6039 Ventilators, I. T. Dando, London.
6040 Sewing Machines, J. Poyser, London.
6044 Oil Lamps, J. Y. Johnson, Middlesex. (C. S. Upton, United States.)—[Complete Specification.]
6045 Lamps for Burning Petroleum, W. D. Gooch, F. H. Varley, and F. B. Lidstone, London.
6046 Coupling for Electrical Conductors, R. von Fischer-Treuenfeld, London.
6050 Nut Lock, A. Davies, New South Wales.—[Complete Specification.]

April 24th.

6060 Twisting Machinery, J. Marjerison, London.
6062 Packings for Pistons, W. Buckley, Sheffield.—[Complete Specification.]
6065 Steam Engines, E. Taylor, Blackburn.
6071 Bearings for Machinery, G. E. Serjent, Newport.
6075 Heating by Electricity, E. E. Ries, London.—[Complete Specification.]
6076 Mariner's Compass, A. Gross, London.—[Complete Specification.]
6080 Railways, J. D. Larsen, London.
6083 Straightening Metallic Tubes, L. L. Burdon, London.—[Complete Specification.]
6084 Milling Twist Drills, A. Whitney, London.—[Complete Specification.]
6088 Carburetted Air for Driving Engines, W. P. Thompson, Liverpool. (E. A. Durand, France.)
6092 Fire Escapes, G. H. Thompson, London.—[Complete Specification.]
6093 Apparatus for Telegraphic Purposes, F. Jacob, London.
6094 Marine Boilers, A. D. Bryce-Douglas, London.
6096 Valve-gear of Steam Engines, J. D. Brisay, London.
6097 Facilitating the Repair of Propellers, H. H. Lake, London. (H. P. Kirkham, United States.)—[Complete Specification.]
6100 Locking Electrical Indicator, J. T. Todman, London.
6102 Extracting Metals from Ores, P. Jensen, London. (E. H. Russell, United States.)—[Complete Specification.]
6103 Ventilator, C. Brothers, London.
6106 Axle Boxes, H. K. Austin, London.
6108 Hot Air Motors, C. Wells and J. T. Pickburn, Middlesex.
6109 Obtaining Power from Waste Steam, C. Wells, Middlesex.

April 25th.

6118 Hydraulic Packing Apparatus, E. L. Bellhouse, of the firm of E. T Bellhouse and Company, Manchester.
6127 Pipe Connections, J. C. Merryweather and C. J. W. Jakeman, Kent.
6128 Fluid Pressure Motors, W. P. Thompson, Liverpool. (E. Lemonon, France.)
6133 Electric Arc Lamps, F. R. Boardman and F. Teague, London.
6134 Sounding Apparatus, S. H. James, Surrey.
6137 Coating the Bottom of Iron Ships, T. Woolley, Southampton.
6146 Valves, A. Delton, London.
6159 Machines for Drilling Holes in Metal, Count A. V. de Vismes, London.—[Complete Specifications.]
6160 Chemical Fire-engines, J. Hall and J. Hall, London.

April 26th.

6168 Paddle-Wheels, H. C. Simpson, Birmingham.
6169 Smoke Consuming Arrangement, W. P. Hoblyn, Cornwall.
6171 Lubricator, J. E. Lawton, Manchester.
6184 Telephones, M. Ruddle, of the firm of Sanderson, Ruddle, and Co., Manchester.
6191 Electric Lighting, C. A. J. H. Schroeder, London.—[Complete Specification.]
6210 Fire-Engines, T. J. Hovell-Thurlow-Cumming-Bruce, Baron Thurlow, London.
6211 Circular Saws, L. Witthofftt, London.—[Complete Specification.]
6219 Hydraulic Apparatus Applicable as a Motor, A. Goodwin, London.
6224 Hydraulic Lifts, T. P. Ford, London.

NOTICE TO NEWSAGENTS AND SUBSCRIBERS.

Numerous complaints having been made to us by Subscribers of the difficulty they experience in obtaining copies of the *Practical Engineer* in certain districts, we have to state that the Journal can be obtained by any Newsagent through the ordinary trade channels, and no difficulty should therefore exist in obtaining copies by order of any Newsagent.

For the information of the trade, we may state that copies can be obtained from either of our Offices in London or Manchester, or from any of the following wholesale houses.

W. H. SMITH & SON, Strand, London.
W. H. SMITH & SON, Blackfriars Street, Manchester.
JOHN HEYWOOD, Deansgate, Manchester.
ABEL HEYWOOD & SON, Oldham Street, Manchester.
J. MENZIES & CO., Hanover Street, Edinburgh.
J. MENZIES & CO., Drury Street, Glasgow.
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EDITORIAL NOTICES.

All communications for the Editor of this Journal should be addressed to 6, Victoria Station Approach, Manchester.

Communications intended for insertion in the current week's issue should reach us not later than Tuesday Evening.

We cannot undertake to return rejected manuscripts or drawings unless accompanied by a stamped and directed envelope.

Contributors are requested to write on one side only of the paper. Sketches should be sent on separate sheets.

TO ADVERTISERS.

Advertisements intended for insertion in the current issue should reach us on Wednesday morning at the latest.

Important Notice to Newsagents and Subscribers.

Our Publishing Offices in London are now at 11, PATERNOSTER BUILDINGS, E.C., where the Trade will in future be supplied.

Simultaneously with the above change, our PUBLISHING OFFICES in MANCHESTER have been REMOVED from Grosvenor Chambers, Deansgate, to more commodious and convenient premises at 6, VICTORIA STATION APPROACH, where all communications intended for the Manager or Editor should, in future, be addressed.

THE
PRACTICAL ENGINEER.
MAY 11TH, 1888.

THE GLASGOW EXHIBITION.

THIS International Exhibition was opened on Tuesday by the Prince and Princess of Wales, and the state of preparation for the event that the Exhibition as a whole showed, coupled with the lively enthusiasm that pervades the great city, augurs well for the success of the undertaking. So far the managers have every reason to be satisfied with things, and we believe that, given as favourable weather as was enjoyed last summer, the success of the Exhibition will be quite as phenomenal as that achieved by the one in Manchester.

The section devoted to machinery is the one that will interest us most, and when things have settled down a little we shall give our readers a brief description of some of the more interesting and important exhibits in this department, along with illustrations of the machines. At present we will confine ourselves to a short description of the section. The Machinery Annexe is over 300ft. long by nearly 300ft. wide, and has a floor area of 140,000 square feet, being about one-third larger than was contemplated in the original designs. There are nine bays running the full length of the building, the centre one being wider than the rest, and is also provided with stronger foundation and supports for the heavier kinds of machinery located in it. A travelling crane, having a 41ft. span, is fixed overhead in this bay, and is capable of lifting 20 tons; the crane is driven from an endless band, and the motive power is supplied by an engine of the inverted type, placed in a corner of the building. Another crane of the jib portable kind is also in use, made by the same makers, Messrs. George Russell and Co., Motherwell. These are the only cranes in the building. Unlike the Manchester Exhibition, the boilers, nine in number, have been supplied by different makers, viz.: two each by Penman and Co., A. and W. Smith, and Wilson, of Glasgow; two by Sinclair, of Leith, and one by D. Adamson and Co., Manchester. They are all made of steel, 28ft. by 7ft. 6in., and will work up to 120lb. pressure. Four engines do all the driving, two of them being of the Westinghouse type, and the other two are by Mirlees, Watson, and Co., Glasgow, and John Cochrane and Sons, Barrhead. The shafting is carried by the vertical columns separating the various bays. The engines and dynamos for supplying the electric light are placed in a separate house, 118ft. by 100ft., adjoining the boiler-house. The engines are by numerous makers—Robey and Co., Adamson and Co., Greenwood and Batley, and others—and form an exhibit in themselves well worthy of inspection. The lighting is done for the most part by the Brush Company, and altogether the light is equivalent to more than 1,000,000 candles. A few rooms are lighted by oil and gas lamps of an ornamental description.

Of the exhibits in the Machinery Section, marine engineering and naval architecture are to the fore, and visitors will agree that the show in these departments is both varied and interesting. Iron and steel manufactures are also well represented, and comprise most of the best known names in the trades. We shall, in due time, deal at length with these exhibits, and will merely conclude now by remarking that the catalogue is a most compact volume, not too bulky, and yet containing all that it is necessary for the visitor to know.

BLACKBURN TECHNICAL SCHOOL.

THE Prince of Wales laid the foundation stone of this promising building on Wednesday, and as the subscriptions amount to over £13,000 already, it is to be hoped the full scheme, costing £25,000, will be able to be persevered in. A modified building—at a cost of £15,000—can be erected, which omits a series of six classrooms for commercial subjects, a section of the chemical department (including the dye-house), and also the elementary art school; but it is said that this, although causing a large gap, will not be of vital importance to the present efficient working of the school. The whole scheme of the school is arranged with special but not exclusive reference to the industries of the district. A good deal of attention will be devoted to textiles, and the processes of spinning, weaving, sizing, and warping will receive due illustration. Carpenters' work, building construction, and metal work of various kinds, including experimental engineering, will also have departments in the scheme. Chemistry is to be a large subject, and drawing is likewise to have special attention. Physics, cookery, and other subjects are also to have classes. The basement contains a textile lecture theatre, seated for 200 students, the trade classrooms, and also the weaving and engineering sheds. The sheds are about 50ft. square. The engines and boilers to supply power are in a sub-basement. All the rooms in the basement have abundant light. The principal entrance on the ground floor is reached by a broad flight of stone steps. This floor has four large classrooms for subjects connected with physics, six for commercial subjects, besides rooms for cookery classes. A fine reception-room, with a panelled dado and a ribbed plaster ceiling, is also included on the ground floor. The whole of the next flat is devoted to chemistry. The laboratory has accommodation for 60 students, and the lecture-room for 280. The dyehouse is spacious, and has a lofty, open-timbered roof. The second floor is given up to art, and includes an elementary drawing-room, an antique-room, and a designers' classroom. Throughout the building light and ventilation have been the first consideration, and extravagant features, such as a tower, have been omitted.

TRANSMISSION OF POWER.—VIII.

ELECTRICITY—II.

CONTINUING the description of the electric pumping arrangement at Trafalgar Colliery, contained in our last article (page 145), we find that when working at the maximum speed of 25 pump strokes per minute the following observations were taken:—

I.H.P. steam engine	29·49
Speed of generator	900 revols. per min.
Volts at terminals of generator	320
Ampères " "	43
Speed of motor	650 revols. per min.
Volts at terminals of motor	260
Ampères " "	43
Actual h.p. of water lifted	10·36

The loss of power is apportioned thus:—

Loss in Engine	6·49 h.p.	=	22 per cent.
" Generator	4·56 "	=	16 "
" Line	3·45 "	=	11 "
" Motor	3·00 "	=	10 "
" Pump	1·63 "	=	6 "
	19·13 h.p.	or	65 per cent.

Of the actual 25 h.p. communicated to generator, the amount actually utilised in water raised is 10·36 h.p., or 45 per cent.

The first cost of the plant is summarised as under, and it will be seen that the pump and water-pipes are not included, as these would be required just the same by any other system of pumping.—

Two electric machines	£310
Insulated copper lead	138
Return wire, iron rope	25
Signal wire	10
Insulators	6
Estimate for steam engine	140
Fixing and sundries	15
	£644

The cost of raising 114 gallons of water per minute by the above machinery, after allowing for all costs, including depreciation, is ·02d. per H.P. on water raised, 1·80d. per 1,000 gallons of water, and the cost worked out is 1·18d. per H.P. per hour. The water is forced through 1,800 yards of 7in. pipes, rising 300ft.

The plant was put down by the colliery mechanics without outside assistance, and has worked without a hitch. The commutators are the principal wearing parts, but with care will run a long time. The wear shown by five months' work is only one-sixteenth of an inch, whilst a full inch can be worn away before a new one is necessary. It is manifest that such a plant as this can be laid down much more easily than either a steam, air, or water-power plant.

The following comparisons of cost of transmission of power by various methods, which appeared in the *Revue Universelle des Mines*, vol. 15, page 522, will be of interest:—

1. Comparative cost on 10 H.P. transmitted 1,093 yards:

	D.	
By Cables	1·77	per effective H.P. per hour.
" Electricity	2·21	" "
" Hydraulics	2·90	" "
" Compressed air	2·98	" "

2. Comparative cost on 50 H.P. transmitted 1,093 yards:

	D.	
By Cables	1·35	per effective H.P. per hour
" Hydraulics	1·87	" "
" Electricity	2·07	" "
" Compressed air	2·27	" "

3. Comparative cost on 10 effective H.P. transmitted 5,465 yards:

	D.	
By Electricity	2·64	per effective H.P. per hour.
" Compressed air	4·66	" "
" Cables	4·69	" "
" Hydraulics	5·29	" "

4. Comparative cost on 50 effective H.P. transmitted 5,465 yards:

	D.	
By Electricity	2·37	per effective H.P. per hour.
" Cables	2·65	" "
" Compressed air	2·99	" "
" Hydraulics	3·02	" "

Steam was the prime mover used in each of the above instances, and it appears that for long distances electricity takes the lead in economy over all other systems. It has also a great advantage in the facility with which the power may be subdivided, and there appears to be no doubt that, in future coal-mining, electricity will be much used for coal-cutting, tunnelling, hauling, pumping, &c., as well as for lighting.

TIMBER FOR PATTERN WORK.—I.

THE study of the microscopical structure of woods, though one of great interest, only comes within our province so far as this, that it explains and illustrates the reason of the behaviour of timber during and after seasoning. The examination of all woods, even the hardest, reveals a series of interlacing vessels, which, developed originally from simple growing cells, have, owing to obliteration or absorption of the cell walls, become the vascular system of the growing plant, through which the vital processes of circulation and nutrition have been carried on. These again, after having fulfilled their function—that is, having ceased to aid plant growth—have still further degenerated into the purely woody fibre, the duramen, or heart wood of the timber. In the exogens, all growth takes place in circumferential layers, forming the annual rings, the zone of actual growth being located in the cambium ring, which forms and grows in the spring and summer, and, lying dormant in the winter, marks off in a tolerably well defined manner the old, or duramen, from the new, or alburnum wood.

The structure of the developed wood of a timber tree being therefore altogether vascular, furnishes the key to its behaviour under various atmospheric conditions. Though the outer layer or layers alone contain the circulating sap, yet the whole vascular system during the life of the plant is distended with moisture. The purpose of seasoning, therefore, is the elimination of this moisture, and the gradual shrinkage of the vessels upon themselves. The interlacing of the groups of vessels in the different woods, and their close or open character, determines the regularity or otherwise in which shrinkage will take place, and also its amount. As a rule, the hard—*i.e.*, close-grained—woods shrink least, but they split most in seasoning, while the soft woods shrink most and split least. In the first case, the vessels lie in such close contiguity that the access of air is hindered; in the second, their open character facilitates such admission. Moreover, in the hard woods the fibres often interlace to so great an extent, that the internal stresses in the fibres due to drying are such that the timber is drawn and twisted out of its original form, causing warp, and curve lengthways, diagonally, and crossways. This brings us now to the practical part of our subject.

Some woods are utterly unsuited to pattern-making, because they will not "stand," their vascular structure not being sufficiently straight and uniform in character. For, be it remembered, it is not enough in pattern work that wood be well seasoned previous to use; it must also be able to bear the action of the moisture in the foundry sand without undergoing material alteration in form. Hence, woods which are well enough adapted to cabinet and joinery work do not necessarily answer for patterns, the former being protected from change in rooms of even temperature, free from the presence of moisture, while the latter are subject to conditions of quite an opposite character. Timber from which the sap has been eliminated by careful seasoning is always ready to re-absorb moisture, in greater or less quantity, into its vessels, with consequent alteration in form. It is partly with a view to prevent this, as far as possible, that a protective coating of varnish or paint is laid upon the best patterns. Yet, spite of such protective coating, when patterns are embedded, as many are, for several hours in the sand, the evil influence of the moisture is apparent in altered outlines, and lapping joints and edges. Hence it may be laid down as a general rule that those woods in which the fibres occur with the greatest regularity are the best for our purpose; also that as very close grained woods do not permit of that free accession of the air to the vessels which is essential to regular seasoning, they are not well suited for pattern work, notwithstanding that their hardness and durability would be a recommendation in standard patterns moulded many times over. Hard, crooked-grained wood is very apt to split during seasoning, simply because the air does not freely penetrate throughout its entire substance, so that such seasoning is not uniform, but more or less localised and uncertain in character.

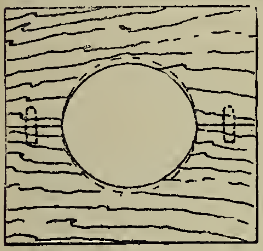


Fig. 1.

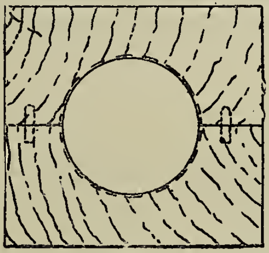


Fig. 2.

In any wood, hard or soft, perfect seasoning is a work of time. After a log is cut into planks and boards, from one to three years should properly elapse before these are used up for patterns. To obtain the best results it is necessary to "strip," or lay the boards in piles in an open shed, twenty or more, one above another, with their narrow strips of wood interposed at intervals of about 2ft. apart, the strips measuring about ¼in. thick by 1in. wide; the uppermost board should then be loaded with weights or stones. The timber is thus absolutely prevented from following its natural tendency to warp or curve in drying, and at the end of one to three years, according to species and thickness, the boards are fit to be taken into the workshop for use. Sometimes currents of warm air are employed to expedite the drying, but in any case the air must not be allowed to stagnate, but be kept freely circulating among the boards, to carry off the moisture as rapidly as possible. Some of the means resorted to for rapid drying, as placing timber near a stove in a close shop, or over a boiler shed, or on the beams of a foundry roof, &c., are not to be commended.

Even when pattern timber is cut out of well-seasoned board or plank, the immediate effect of direct exposure of new grain to the air is to cause a certain amount of shrinkage and warping to take place, and this happens as often as freshly-cut surfaces are opened out, because, according to the relative conditions of the atmosphere and of the timber, absorption, or else evaporation of moisture, will take place. In the hard, cross-grained woods, owing to the condition of internal tension into which the grain is thrown by the shrinkage of the interlacing vessels and fibres, it not unfrequently happens that the sawing up will be followed by the immediate curving or winding of the strips sawn out. In some of the harsher-grained soft woods the same thing occurs, so that in such timber it is sometimes desirable to make a little extra allowance on this account for planing up. Some stuff, again, will "go," or become "cast," even in the act of planing up.

In all good work the sap wood, which corresponds with the alburnum or growing zone, should be discarded, being soft, comparatively spongy, and liable to premature decay. In most pattern woods this occupies less relative bulk than in some of the harder fancy kinds. It is at once recognisable by its difference in colour.

The behaviour of different kinds of timber has therefore to be taken into account when constructing patterns, and not only so, but the direction of the grain is a vital factor which must be regarded if patterns are to be made for permanence. Bearing in mind the tubular or vascular structure of woods, we see that shrinkage or expansion can only take place in one direction, that is in the width, in which direction the walls of the vessels approach each other on the evaporation of their enclosed moisture. Here, then, the judgment of the workman is brought into requisition so to construct his patterns that the shrinkage or expansion which is more or less unavoidable in the best seasoned timber shall not be detrimental to their accuracy. Thus, taking a core box (fig. 1) made "plank way" of the grain, when shrinkage occurs the hole must become elliptical, as shown; but in fig. 2, made end way of the grain, the result of shrinkage is simply to diminish the diameter of the hole equally all round, an evil of less moment than the other. The same remark will apply to a pinion cut from solid stuff or to any piece of cylindrical work. It is because of this unavoidable shrinkage of grain that work is built up in various ways by "lagging," or by crossing the grain, or in segmental arcs, by which devices shrinkage, though not prevented, is so localised that comparatively little evil follows from dryness on the one hand, or from the presence of moisture on the other. In these arrangements of the grain there is room for much exercise of judgment. Much may be done by the selection of the driest stuff and the protection of the wood by means of varnish or paint from atmospheric changes and from the moisture in the mould, but even after that the judicious selection of timber and suitable arrangement of grain are none the less essential. In a succeeding article I shall note the principal kinds of timber employed in pattern work, together with their characteristics. J. H.

WARMING RAILWAY CARRIAGES.

To utilise the two waste products from the steam engine is a question as old as the invention of the steam engine itself. Some inventors have directed their genius to economise the steam both in the cylinder and after it has left the cylinder; hence the many devices for expansion, and for using up the exhaust steam and the heat it contains. Others have turned their attention to the utilisation of the waste heat from the boiler furnace; hence the various forms of fuel economisers, &c. But in both these respects the locomotive engine has been almost exempt. It is at present throwing away its exhaust steam at two or three atmospheres pressure, and sometimes more, which is equal to the full boiler pressure of many of our stationary engines driving large mills and workshops. It is also throwing the whole of its waste heat from the furnace, sometimes 700 or 800 degrees in temperature, up the chimney.

With such an amount of valuable heat from both these sources absolutely wasted, it seems a reflection on our engineering skill and mechanical genius that hitherto no portion of this waste heat should have been utilised in warming the carriages of our railway trains and steam tramcars, instead of the present costly method, with its immense wear and tear, of portable foot-warmers heated with hot water, as in this country, or the still more objectionable and dangerous method of stoves, which obtains in America and on the Continent, attended as they have been with such frightful calamities as setting the train on fire and roasting the passengers alive.

The difficulty of conveying the exhaust steam through the carriages is at once apparent, in the certainty that in frosty weather, when most needed, the water from the condensed steam would be immediately frozen, the passages thereby choked up, and the pipes split with the expanding ice. This difficulty, however, does not apply to hot air, and the idea has occurred to one who was formerly an Oldham working engineer, John Langfield, to pass a current of air by the momentum of the train through an iron or copper vessel suspended near the end of the tubes in the smoke box, where it immediately becomes heated by the waste heat, and then passes through a pipe into each carriage of the train, where it displaces the cold, chilling atmosphere so often at freezing point, raises it to 50 or 60 degrees Fahrenheit, thus rendering railway travelling as comfortable in winter as in summer.

Although this has been the dream of his waking and sleeping moments for a considerable number of years, and he patented his invention some time ago, it is only during the present year that he has succeeded in inducing the enterprising Bradford and Shelf Steam Tram Company to apply it, and thus demonstrate not only its practicability and utility but also the small cost of its application in the first instance, and literally no expense or inconvenience afterwards, except the wear of a short length of flexible tube with bayonet joints to each carriage, similar to those now used for the vacuum brake, with complete success.

Mr. Langfield's long-cherished idea is now an accomplished fact, notwithstanding the difficulties and discouragements he has met with. It can be seen at work on No. 10 engine running between Bradford and Shelf, where by the courtesy of Mr. Darbyshire, the managing engineer of the company, the writer was recently permitted to examine and test it. Not only does the air pass through the vessel and tube when the engine is travelling, but there is a considerable current when it is standing still, so that the temperature of the carriages can easily be maintained. In fact, they have more heat than they require, and have frequently to diminish the supply by the regulating valve, as it is found that gentlemen with overcoats and ladies with outer garments do not require a temperature of more than about 50 degrees when travelling. At the time of the writer's visit the thermometer in the car stood at 54 degs., and the air passing through the pipe with the engine standing registered 70 degrees.

The apparatus is exceedingly simple and inexpensive, whilst the flexible tube, with instantaneous bayonet couplings before alluded to, renders it easy to attach or detach, as circumstances may require.

COMPOUND LOCOMOTIVES.

(CONTRIBUTED.)

The most important problem to be solved by railway superintendents at present is a growing demand for more power, along with economical working; the trains now being run on most of our leading lines having within the last few years reached such proportions that "double heading" and "piloting" is constantly needed.

There have been several attempts made to meet this, and with what success remains to be seen. One of the most successful of these attempts is that of Mr. Webb, locomotive superintendent of the London and North-Western Railway. Mr. Webb meets the demand in a style that commands the admiration of nearly everyone acquainted with his system of compounding, that being the means used by him to obtain this extra power.

Compounding on this system requires three cylinders, two high-pressure and one low-pressure. The high-pressure cylinders are placed outside the frames, and have the connecting rods coupled to the hind driving wheels. The low-pressure cylinder is placed inside the frames, the connecting rod being coupled to the leading driving wheels. The sizes of these cylinders in Mr. Webb's latest engines are two high-pressure cylinders, 14in. diam. and 24in. stroke; one low-pressure cylinder, 30in. diam. and 24in. stroke. It will be seen that this disposition of the engine gives exceptional facilities for enlargement of the chief bearings, while at the same time the strains on these are reduced by one-half. Coupling rods to trailing wheels—or to be more exact in this case, hind driving wheels—are entirely dispensed with, there being no "trailing" in this arrangement. This, it is evident, relieves the engine of the strains due to coupling rods and uneven wear of tyres. Another advantage arising from the absence of coupling rods is unusually smooth running, owing to the independent action of the driving wheels.

Through pipes led from the smoke box the steam is admitted to the high-pressure cylinders; these being coupled at right-angles, the engine is as easily handled as non-compounds coupled in the same manner, thus obviating one of the defects of the Worsdell and Von Borries' system, and that is the necessity of admitting steam to the low-pressure cylinder before the engine is able to start. From these cylinders, after performing the duty of turning the hind driving wheels, the steam is led back to the smoke box, the pipes conveying it here rising and crossing over to the opposite sides of the low-pressure steam chest, these pipes, to a certain extent, thus acting the part of a superheater. On one of these pipes is placed a valve loaded to 80lb., the pressure of the steam in the low-pressure cylinder not being meant ever to exceed this, as it is about the highest pressure consistent with economical working when the initial pressure of 175lb. is taken into account. After doing its work in the low-pressure cylinder, the steam, now greatly reduced in pressure, exhausts into the atmosphere through an improved nozzle on the blast pipe, which discharges the steam in a ring jet striking the chimney somewhere near its upper edge. The action of this nozzle, as well as the reduced pressure and number (half) of exhausts, effects a full saving of about 10 per cent over the non-compounds superseded by these engines. If the extra power obtained, however, be taken into account, the percentage will reach far above this. Another feature in connection with this system is the arrangement of reversing gear, which allows of the grades of expansion in either high or low pressure cylinders being regulated independently or simultaneously as desired, which is found to render great assistance in cases where the trains happen to be very light or very heavy. There are numerous other details of construction, all worthy of description, but they would require more space than it is desirable to take up at present; but on the whole it must be admitted that Mr. Webb has made a long step forward in the way of improvements, and so is to be congratulated accordingly.

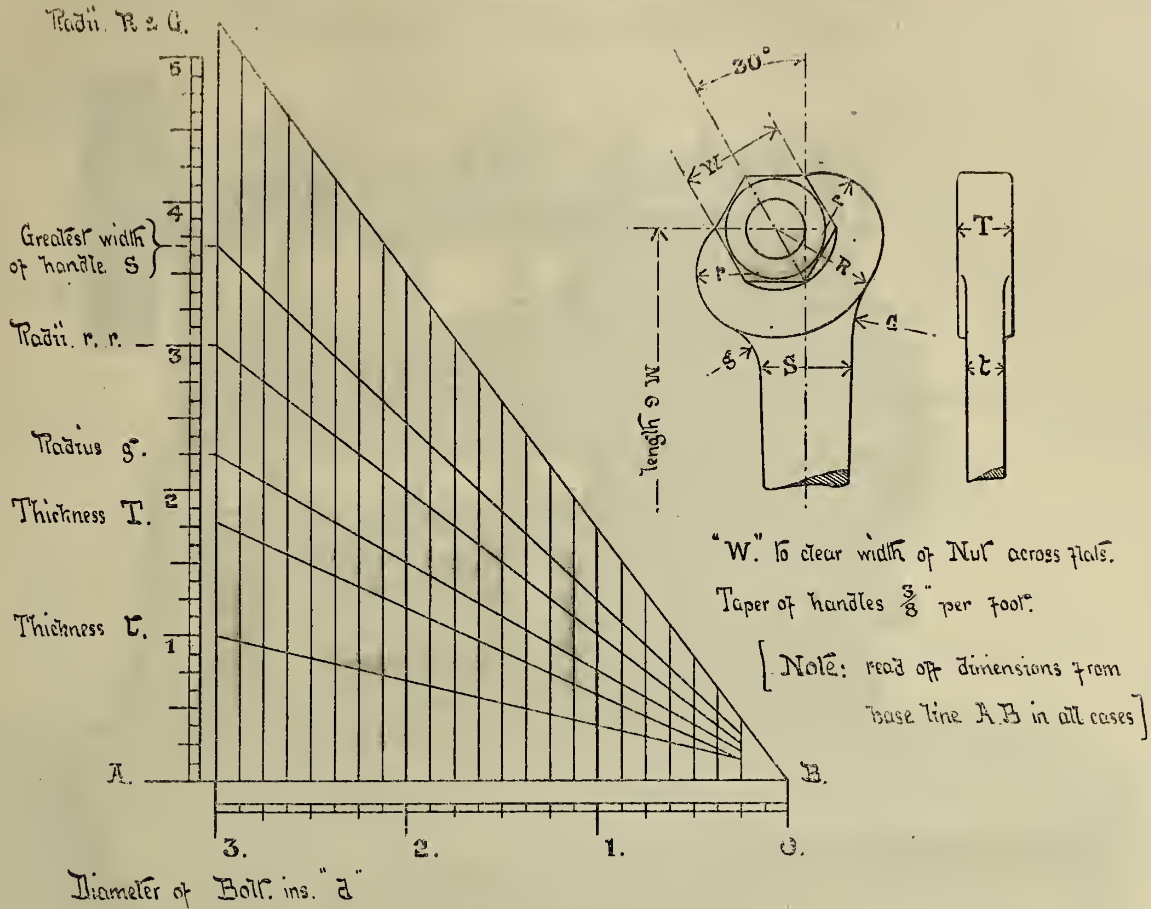
Dreadnought.

HYDRAULIC POWER IN LONDON.

(Concluded from page 213.)

In addition to the general supply of hydraulic power, in the city and adjoining districts, to the six hundred and fifty machines at present worked, a new departure had been taken by the application of hydraulic power to an estate at Kensington Court, the name given to an area of about seven acres facing Kensington Gardens. Seventy houses and dwellings were to be built on this estate, of which thirty had been already erected. Each house was fitted with a hydraulic lift, taking the place of a back staircase, and the power supply was provided on the estate expressly for working these lifts. The driven machinery was as of great importance to an economical and satisfactory result as the distributing plant, but this obvious fact was not always understood. General regulations had been prepared by the author, defining the conditions to be observed by manufacturers in fitting up machinery for connection to the power mains. They were intended to secure safety, and an efficient registration of the quantity of power used; but they left the question of the economy and of the efficiency of the machines to be settled between the consumers and the makers. In London more lifts were working from the mains, and more power was used by them, than by any other description of machinery. The number of all classes at present at work was over four hundred. The principal types in use were fully described. In some cases there had been, by adopting the public supply, a saving in the cost of working of about 30 per cent as compared with the steam pumping plant previously in use. Lifts were now becoming so general, and the number of persons who used them was so great, that the author considered it necessary to urge the importance of securing the greatest possible safety in their construction by the general adoption of the simple ram. Suspended lifts depended on the sound condition of the ropes or chains from which the cages hung. As they became worn and unreliable after a short period, it was usual to add safety appliances, to stop the fall of the cage in case of breakage of the suspending ropes, but they could not be expected to act under all circumstances. As an indication of the important part which lifts occupied in a modern hotel, it might be mentioned that at the Hotel Metropole there were, including the two passenger lifts and that for passengers' luggage, no less than seventeen hydraulic lifts in use day and night, while the work done represented about 2,000 tons lifted 40 feet in this time. The next largest use of the power was for working hydraulic cranes and hoists of various kinds along the river side and in the city warehouses. It often happened that the pressure in the power mains was not sufficient for pressing purposes. The apparatus known as an intensifier was then used, by which any pressure required could be obtained. Hydraulic power was also used at Westminster Chambers, and elsewhere, for the purpose of pumping water from the chalk for domestic use. The pump was set going in the evening, and continued working till the tanks were full, or until it was stopped in the morning. For work of this kind, done exclusively at night, a discount was allowed from the usual rates. Mr. Greathead's injector-hydrant, made at the Elswick Works, had been in use to a limited extent in London in connection with the power mains. A small jet of

PROPORTION OF SPANNERS.



"W." is clear width of Nut across flats.

Taper of handles $\frac{3}{8}$" per foot.

[Note: read off dimensions from base line A.B in all cases]

high-pressure water, injected into a larger jet from the waterworks mains, intensified the pressure of the latter in the delivery hose, and also increased the quantity. By this means a jet of great power could be obtained at the top of the highest building without the intervention of fire engines. This apparatus enabled the hydraulic power supply to act as a continuous fire engine wherever the mains were laid, and was capable of rendering the greatest assistance in the extinction of fire; but there was an apathy on the subject of its use difficult to understand. In Hull, the Corporation had put down a number of these hydrants in High Street, where the hydraulic power mains were laid, and they had been used with great success at a fire in that street. The number of machines under contract to be supplied with power was sufficient, with a suitable reserve, to absorb the full capacity of the station at Falcon Wharf, and another station of about equal capacity was now in course of erection at Millbank Street, Westminster. The works had been carried out jointly by the author and Mr. Corbett Woodall, M.Inst.C.E. Mr. G. Cochrane had been resident engineer and superintendent. The pumping engines, accumulators, valves, &c., and a considerable portion of the consumers' machinery, had been constructed at the Hydraulic Engineering Works, Chester. Sir Jas. Allport, Assoc.Inst.C.E., who was the first to adopt hydraulic power for railway work, had been associated with the enterprise from the commencement of its operations in 1882. His wide influence and extended experience had greatly assisted the commercial development of the undertaking.

PROPORTION OF SPANNERS.

The appended diagram of "proportion of spanners" gives, graphically, the proper dimensions of spanners for the nuts of bolts up to three inches in diameter. The centre line of the jaw is shown at an angle of 30° from the vertical, which is that most commonly adopted, although not the most suitable as far as strength is concerned, but certainly more applicable to a nut in ordinary cases than those in which this angle is made equal to 45°. If it be required to turn the spanner in the smallest possible space, the jaw is made at an angle of 15° with the vertical.

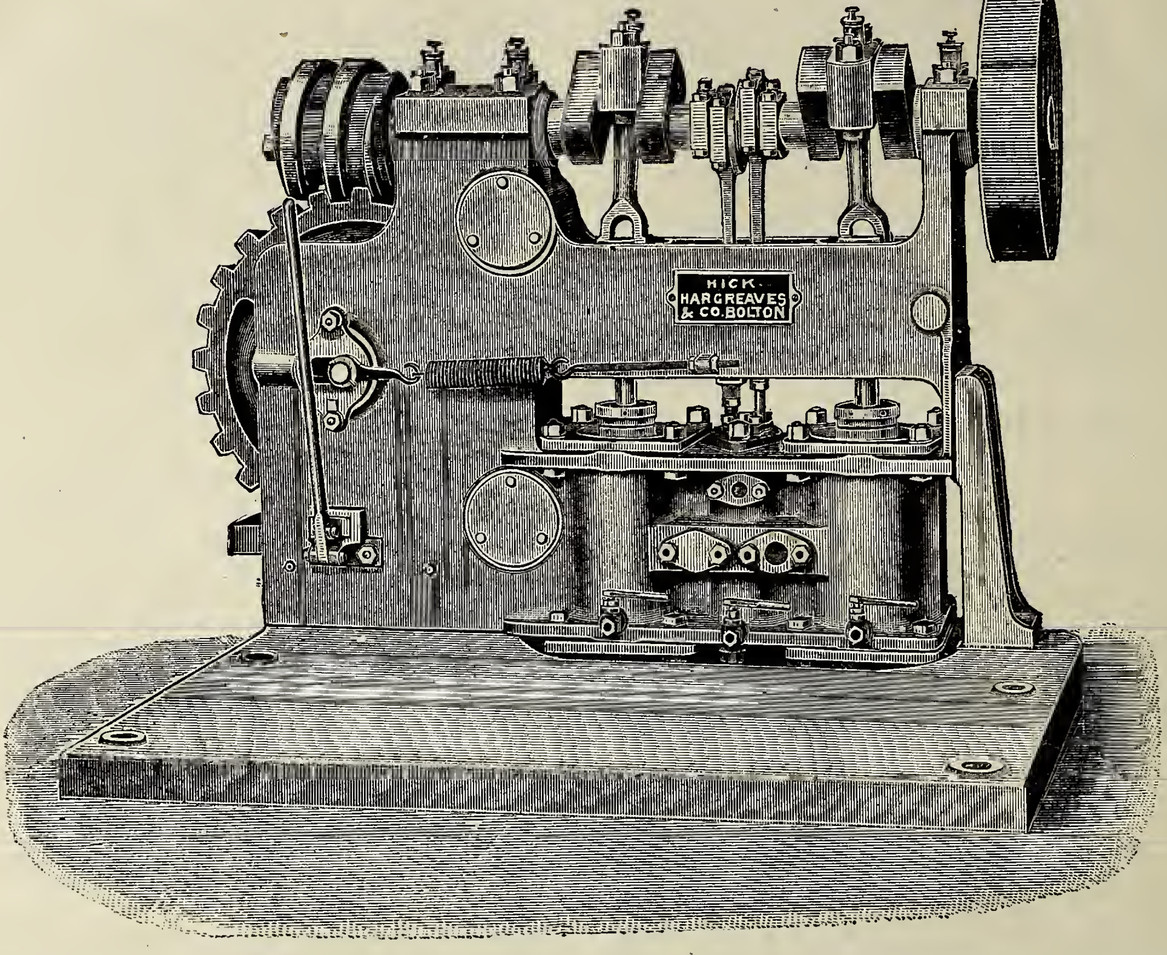
The length is generally about eight or nine times the width of the jaw, but, as the length determines the leverage, it should be proportionate to the size of the nut and the number of threads in the screw; for if it be made too long, an undue strain is liable to be put on the bolt, and cause it to twist off. Taking for example an 1$\frac{3}{8}$in. stud, which equals one square inch in area at bottom of thread, and if made to the Whitworth standard would be screwed with six threads per inch, or ·167in. pitch, and a corresponding width of nut of 2$\frac{1}{16}$in., the length of the spanner would be eighteen inches, and the circumference described by the hand at the end of the spanner $18 \times 3{\cdot}1416 = 113$in.; so that to move the nut one inch along the screw the hand would have to move 6×113, or 678in., and in order to exert a strain of one ton in drawing the work together it is only necessary to put a pressure on the end of the spanner of $\frac{2240 \times {\cdot}167}{113} = 3{\cdot}3$lb., but to allow for friction and indirect strain it is necessary in practice to multiply this by four, which gives 13·2 as the applied pressure at the end of the spanner.

Also, taking the torsional breaking strain of the material of which the stud is made at 18,000lb. for a round bar of one inch sectional area, then $\frac{18{,}000 \times {\cdot}167}{113} = 26{\cdot}6$, and again multiplying this by four $= 106{\cdot}4$lb. as the power applied sufficient to break an 1$\frac{3}{8}$in. stud; thus, it will be seen that with an ordinary long spanner it is an easy matter for a fairly strong man to twist such a stud off.

Locomotives for Canal Work.—The London and North-Western Railway Company have decided upon a very important experiment with regard to their canal traffic. The company own the Shropshire Union Canal, and they have determined to try the effect of having locomotive engines to draw the canal boats instead of horses. Orders have been received at Crewe Railway Works for the construction of several engines of a small pattern to run on sets of rails to be laid alongside the canal. New canal boats are also being built. The experiment will be made between Chester and Shrewsbury.

BARRING ENGINE.

CONSTRUCTED BY MESSRS. HICK, HARGREAVES, AND CO., BOLTON.



Mill engines frequently stop in such a position that it is necessary to turn them often through a considerable angle before they will start; or it is necessary sometimes to turn them round very slowly when putting on ropes, belts, or doing repairs, or to expel the water which accumulates in the cylinders. It will, therefore, be seen that a barring engine is a most useful adjunct to a mill engine, as the labour of "barring" round by hand is very severe, and, with the increasing size of modern engines, is becoming almost impossible.

It is desirable that barring engines should be fitted with a disengaging apparatus, whereby, if steam be turned on to the main engine before the barring engine is released, it can automatically throw itself out of gear and thus prevent an accident.

Messrs. Hick, Hargreaves, and Co.'s Barring Engine, which we illustrate, consists of a small double-cylinder vertical engine, with a worm keyed on to the outer end of the crank shaft; this worm gears with a worm wheel, the teeth of which are shaped on one side like worm-wheel teeth, and on the other side like ordinary spur-wheel teeth, to gear into teeth formed on the flywheel rim for this purpose. The axle of the worm wheel runs in an inclined slotted bearing, so arranged that when it is at one end of the slot the wheel engages with the teeth on the flywheel rim, and when at the other end of the slot the wheel is out of gear. In the engraving the slot is shown horizontal, and a spiral spring keeps the wheel out of gear; but an inclined slot has been substituted for this arrangement, which requires no springs. When it is required to put the barring engine into gear a brake-block is pressed against the rim of the worm wheel at the opposite side to the worm. This point then becomes the fulcrum or centre on which the wheel revolves for the time being, and the wheel is pushed forward by the revolving worm until it engages with the teeth on the flywheel. The brake falls off automatically, and the wheel continues to turn the flywheel round until the main engine starts of its own accord, which reverses the whole action, for as soon as the speed of the flywheel rim exceeds the speed at which the worm is advancing, this becomes the fulcrum upon which the worm wheel pivots, and the axle rolls to the opposite end of the slot, where it is quite clear of the main engine, the whole action being entirely automatic.

These barring engines are made in various sizes and of different forms, to suit the positions in which they have to stand and the direction of revolution of the flywheel rim.

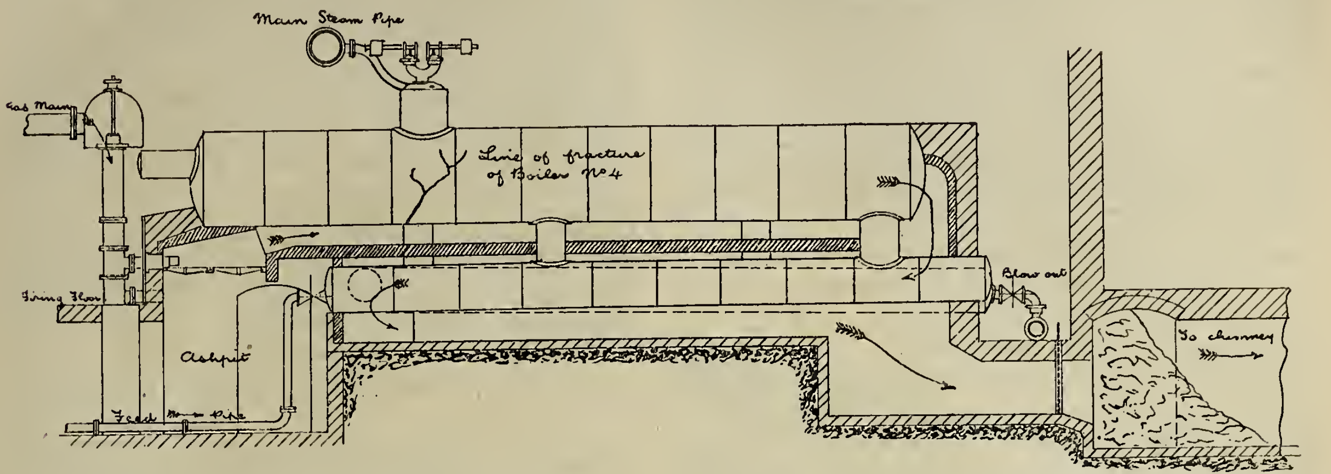
Messrs. Hick, Hargreaves, and Co. claim to have been the first to make this class of engine with the driving parts arranged to throw out of gear automatically by the starting of the main engine. A large number of these engines are at work in various parts of the world, all giving entire satisfaction.

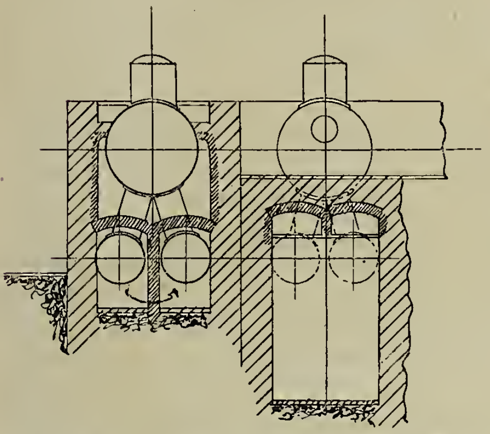
THE FRIEDENSHUTTE BOILER EXPLOSION.

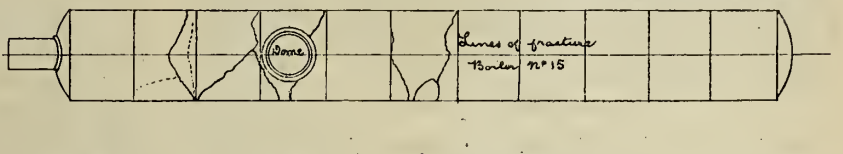
The boiler explosion which occurred at midnight on July 24-25, 1887, at Friedenshutte, in Upper Silesia, was a disaster so unique in its extent and destructive results as to deserve a more extended consideration than we usually give to such accidents. We therefore give below some particulars of the occurrence, for which we are chiefly indebted to the Special Report of a Commission of six German Chief Engineers to the Central Union of Prussian Associations for the Inspection of Steam Boilers.

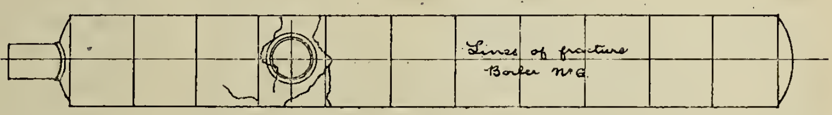
As shown in the plan, the boilers lay in a range of 22. They were of the ordinary elephant type, as indicated on the sketches. The upper cylinder of each was 40ft. 2in. long and 5ft. 2in. diameter, of $\frac{1}{2}$in. plates, single riveted. The lower cylinders were each 38ft. 6in. long and 2ft. 7in. diameter, of $\frac{5}{16}$in. plates. The two lower cylinders were each connected to the upper cylinders by two necks of $\frac{7}{16}$in. plates, and further there was one neck connecting the two lower cylinders together. The boilers were well equipped, and provided with all usual safeguards. The boilers

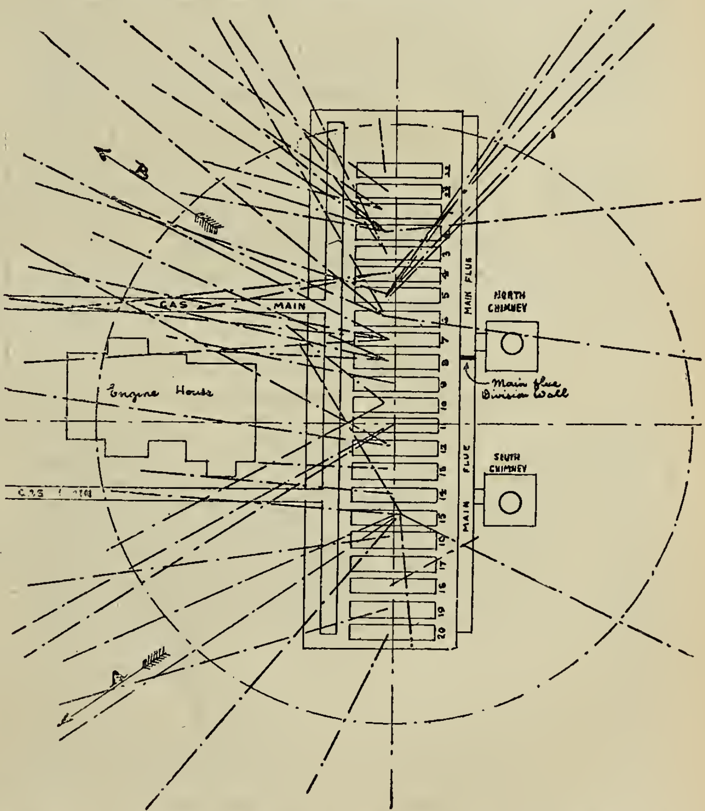
THE FRIEDENSHUTTE BOILER EXPLOSION.











were heated by blast-furnace gas. This was supplied by the mains shown on the sketch, and was delivered above the grate (of 35·5 sq. ft.) by a tuyere. A light fire was maintained on the grate, with the object of securing the continued ignition of the furnace gas. For this object only very light firing was necessitated—about 2·46lb. of coal per square foot of grate per hour. The boilers supplied steam to the blast engines. To do this required eighteen of the boilers, and hence four were usually at rest. At the time of explosion Nos. 1, 3, 16, and 20 were at rest. After an ordinary day's work, during which nothing out of the usual course had taken place, between the hours of twelve and one midnight, the explosion took place, resulting in the destruction of the whole range of 22 boilers, converting the boiler-house and surroundings into a heap of ruins, killing twelve persons, severely wounding five, and slightly wounding thirty. The destruction of the boilers was so complete as to render the identification of the different fragments in many cases altogether impossible, while the heap of debris, and the utter confusion in which the ruins of boilers, flues, fittings, and buildings were involved, altogether prevented that species of induction by which the causes of boiler explosions can usually be determined with a considerable degree of certainty. Under these conditions of uncertainty it will easily be understood that there has been the usual crop of probable and improbable theories to account for the result, none of which, however, explain the whole of the circumstances of the case, and none of which can be wholly proved or disproved.

We give a plan showing the direction of the flight of the pieces of the boilers. The parts to which the plan refers were pieces of the upper cylinders. These as a rule were the only pieces of the boilers projected, the lower cylinders remaining in or near to their original positions. The upper cylinders were fractured generally in a transverse manner, as shown on the sketches.

All the persons who had charge of the boilers being killed, and in the absence of any direct evidence pointing to the cause of the disaster, it is necessary to consider what conditions of explosion the circumstances of working would allow. The safety valve equipment, the arrangement by which the boilers received most gas, and were hence most heated when the blowing engines were using most steam, would appear to preclude the existence of an excessive pressure.

At the same time, the fact that the fractures were transverse, and not longitudinal, shows conclusively that the explosion was not due to the accumulation of steam pressure. The absence of any traces of general over-heating of the plates proves that shortness of water did not exist. The remaining possibility is that of a gas explosion, and the general evidence points conclusively to this as the cause of the disaster. This might be caused either by an explosive mixture of blast-furnace gas and air, or by a mixture of these gases with gases from the coal on the grate. The latter would be capable of producing a much more severe explosion than the former, although the former would be sufficient to produce the effects of this explosion.

In support of the theory that the main effect was due to a gas explosion are the facts that the empty boilers received injuries similar to those at work, that the upper cylinders only were affected, that the parts of the cylinders were generally partly collapsed and the edges of the fractures turned inwards, and finally that the direction of the flight of the pieces and destruction of the flue brickwork, and collapse of the main flue, point to an explosion of gas taking place in the boiler flues.

An inspection of the plan of the flight of pieces would appear to indicate an initial disturbing force at the back of the boilers, between the two chimneys. Although theories of the origin and operation of the explosion may be formulated in detail from the occurrence of the first fracture, in the final result it is questionable whether much more than has been indicated above will ever be determined with certainty. We must not omit to mention that a most important contributory cause, at anyrate in the extent of the explosion, was the fact that all the boilers except two were made in 1870-2, at the time of the inflation in iron, and that, as was the case with very many boilers constructed at that time, the plates were of poor and brittle quality.

The explosion occurred during the mealtime of the night shift, and it is possible that a large amount of slack had been put on, so extinguishing the flame. The gases had then accumulated in the flues until an explosive mixture was formed, which, on ignition, caused the disaster. The report concludes by stating that it is not desired in any way to imply that blast-furnace gas should not be utilised for firing boilers. This may be done with safety, provided that special precautions are taken that the gases are always kept ignited. E. G. H.

THE SHELL PLATING OF IRON AND STEEL VESSELS.

With the transition from iron to steel in shipbuilding, there have been changes in practice of an economical tendency. Not only is there an absolute saving in the weight of material employed, directly owing to the reduced scantlings, but there are other economies indirectly effected. Conspicuous among these is the lessened amount and cost of labour expended in the process of shell plating, *i.e.*, in covering externally the framework of the hull.

This arises from the increased length, breadth, and area of plates permissible by the more liberal limits allowed by steel manufacturers. Without taking any special or extreme case, it is not many years ago that the usual dimensions of a midship shell plate was ten feet in length and four feet in width. The latter could not be exceeded without an extra ten shillings per ton being paid to the manufacturer. Now smaller shell plates are, even in shipbuilding yards boasting only of moderately modern plant, usually 14ft. in length and of correspondingly increased width. Thus there are fewer plates in the length of a strake, and fewer strakes in the girth of a vessel, with a corresponding saving in the number of butt straps and overlaps. Along with the reduction of material, there has also been, necessarily, reduced labour in the process of fitting butt straps. Economy does not end here. Although the length and width of shell plates and their weights have on an average increased, yet there has not been a relative increase in the price paid per plate. Formerly it was customary at some of the shipbuilding centres to pay a fixed sum to the plater for all plates not requiring furnacing, and a fixed sum for each helper employed by the plater. This was known as the "corner" system, but it is fast dying out. Under it, the ordinary garboard, or keel plates, were each paid for as two plates, as also those at the extreme ends of the vessel. In the case of the boss plates in a screw steamer greater allowances were made. Now, however, it is more customary to let out by contract, to several platers, the entire plating of the shell, at an average price per plate—about 8s. 6d. for plates averaging between eight and nine hundredweight—the platers engaging their helpers on the ordinary day-work system. No doubt this change of practice has been facilitated by the depressed state of the shipbuilding industry.

Attention has been directed to the economies effected by the use of larger plates; but in some cases, instead of a saving, a loss may accrue from the ordering of plates so large that they cannot be completely punched, owing to the gap of the machines available not being sufficient. This is a fruitful cause of otherwise unnecessary drilling in shipbuilding yards. No doubt, in individual instances, it may be more economical to incur the expense of drilling a number of holes than to have an additional seam of riveting. The question should, however, receive careful attention.

Another way in which large plates may prove uneconomical is in the case of those towards the ends of full vessels. These plates have frequently so much fore and aft and athwartship set, and require such a considerable margin for shearing, that, along with the difficulty of making them fair, it has been found advisable to cut them in two, to ensure a good job. The result may be, that instead of saving riveting, the draughtsman has caused additional riveting; as, for instance, if a number of plates have been ordered 18ft. in length, and have been found practically unworkable, and cut in two, there is an increase of riveting over what there would have been had the plates been ordered 14ft., and successfully worked. Draughtsmen should not be above taking the opinion of foremen platers as to the best and most economical length for a plate, especially where there is extra curvature. Not that the writer would recommend a draughtsman to blindly follow the dictates of an outside foreman, for some of them have too liberal ideas as to the allowances there should be on all plates that have to be subjected to the shearing process, and possibly too conservative notions as to the impropriety of deviating from the ordinary routine.

A NAPHTHA LAUNCH.

A launch, the engines of which are driven by the vapour of naphtha, has just reached England from America. The launch is 18ft. long by 5ft. beam, and 2ft. 6in. deep, and is fitted with a two-horse power naphtha engine driving a screw propeller. She will carry from six to ten persons at a stated speed of from six to eight miles per hour. In her bows is a stone tank capable of holding between 30 and 40 gallons of deodorised naphtha. Close in the stern of the boat are the engines and vaporiser, which only cover an area about 18in. square, thus affording far greater space for passengers than in a steam launch of the same size. The oil vaporiser or retort, which corresponds to the steam boiler of an ordinary engine, is a coil of tubing, and to start the engine this coil is first heated by a burner placed beneath it. By means of an air pump fixed near the engine, and worked by hand, air is forced into the naphtha tank and returns thence to the burner in the form of a gas, which is ignited and heats up the retort. When sufficiently heated, which will be in the course of a few minutes, a naphtha pump is started by hand, and naphtha is pumped from the tank in the bows to the retort. Here it becomes vaporised, and when the pressure is sufficiently high, as indicated by a gauge, the vapour is admitted to the cylinder of the engine, which is now driven by it, and which in turn drives the screw propeller. The gas burner is now no longer supplied with gas by means of the hand pump, but with fuel from the retort by means of an injector. When once started the engine feeds itself and performs all other necessary functions. Speed and pressure are regulated by the injector valve, which is opened to increase and closed to reduce the speed. The forward and backward motions of the engine are governed by the turning of a hand wheel. The naphtha vapour, after having done its work in the engine, is condensed and forced back into the tank to be re-used. The consumption of naphtha is that due to the heating burner, and with a two-horse power engine this is stated to be from three quarts to one gallon per hour. There are many advantages attendant upon this system of propulsion, which was described by Mr. Yarrow at the last meeting of the Institution of Naval Architects, and illustrated by drawings of a 40ft. launch built and engined by him on this principle. In the first place, there is more room for passengers than in an ordinary steam launch, as the engine and retort occupy so small a space. Then there is rapidity in getting up power, starting, and stopping, and great cleanliness, which is due to the absence of the dirt and dust accompanying the use of coal.

THE MANCHESTER SHIP CANAL.

The Manchester Ship Canal Company have resolved, with the consent of the Corporations of Manchester and Salford, to alter their dock scheme in some material particulars. The proposals first submitted by the company to the Salford Corporation (who were primarily interested) were (1) to alter the size and shape of the large triangular dock south of the Manchester Racecourse; (2) to construct the main locks immediately south of the Salford Cemetery instead of at the western end of the racecourse; (3) to dispense with the two large docks originally intended to be constructed between Trafford Road and Messrs. Goodwin's soapworks on the river Irwell; (4) to widen the main channel of the canal from the locks up to near the Trafford Bridge, forming quays on each bank; and (5) to construct a swivel or rolling bridge over the river below the present permanent bridge, which would have to be removed. The effect of the proposed changes would be to remove a large extent of dock area southward into the township of Stretford; but the company have agreed, at the instance of the corporation, to obtain authority from Parliament to make the centre of the Ship Canal the municipal boundary, by which means the borough will obtain a slight accession of area. They also undertake to construct a dock not less than 3½ acres in extent between Messrs. J. and M. Worrall's works and those of Messrs. Goodwin Brothers; that Trafford Road shall be diverted, and that an opening bridge shall be constructed across the Irwell at the bottom of Fairbrother Street, securing easy access from Salford to Chester Road and the adjacent districts. A bill is being promoted to give legislative sanction to the arrangement, and the Salford Council have agreed to petition Parliament in favour of a suspension of the standing orders so as to ensure the passing of a bill during the present session. The Manchester Corporation will give their support to the scheme provided the benefits secured to the city by Act of Parliament are in no way prejudiced, and that the facilities in connection with the sewage scheme, already provided for, are duly granted.

INCREASING THE ADHESION OF LOCOMOTIVES.

Patents have been taken out in the United States for increasing the tractive power of locomotives and other self-propelled railway vehicles by electricity, which promise to be of very considerable importance, both from a scientific and practical standpoint. These patents (says the *American Engineer*) cover broadly the use of an electric current for increasing the frictional adhesion between the driving wheels and rails, and the patentees have found that by this means the tractive power of locomotives and self-propelled motor cars can be nearly doubled without any increase in their weight, and also that no retardation is offered to the motive power by reason of the traction. The increased traction is due to a temporary molecular change in the metal at the points of contact between the driving wheels and the track rails, caused by the passage of one to the other of a "transformed" electric current of large volume and small electro-motive force or pressure. The current is generated, according to one of these patents, by a small dynamo-electric machine carried by the locomotive, from which, after being passed through an electrical convertor, it is made to pass through, and traverse in succession, all of the driving wheels and that part of the track rails lying between them, which latter serve to complete the circuit as the locomotive or motor car moves along. The amount of increased traction thus obtainable is described as being very great, and can be regulated to suit the requirements by means of a simple switch that controls the flow of current through the "traction circuit." In experiments recently made before several of the Patent Office Examiners, the fact that the passage of the electric current increased the tractive effects in the manner claimed by them was thoroughly demonstrated, and a small railway car equipped with the device ascended and descended, without the least difficulty, a grade of forty per cent, or 2,088 feet to the mile, whereas a seven per cent grade in practice can be surmounted only with the greatest difficulty under the most favourable circumstances by ordinarily equipped locomotives.

PRIESTMAN'S PETROLEUM ENGINE.

For some time past Messrs. Priestman Brothers, of Hull, have been endeavouring to overcome the difficulties which have hitherto stood in the way of using the ordinary petroleum of commerce as a motive power for engines. In this they have now fully succeeded. The oil is placed in a closed tank inside the foundation of the engine, and air is pumped into this tank until a pressure of about 5lb. to the square inch is obtained. The oil is then mixed with air until it is formed into a vapour, after which it passes into a closed iron vessel or vaporiser, where it is heated, and from which it is admitted into the engine cylinder and ignited by means of an electric spark. The spark is obtained from a small primary battery capable of doing about 30 hours' work without attention, and which can be renewed at a very small cost. In starting the engine the vaporiser is heated for a few minutes, after which the necessary heat is obtained from the exhaust products of combustion while on their way to the chimney. The cylinder is water-jacketed, the water being kept in circulation by a small pump. After it has once been started the engine works automatically, preparing its own source of power, heating its charge, cooling its cylinder, and supplying its own spark for ignition. The great point here is that only ordinary petroleum is used, which, moreover, is entirely consumed, leaving no residue whatever, the combustion being complete. The cost of working this engine, taking the oil at the present price, is stated to be a little more than a halfpenny per horse power per hour. The engine is simple in construction, and is well adapted for use where steam is admissible and coal gas not obtainable. It has been thoroughly tried and proved in practical work.

LARGE PUMPING ENGINES.

The tenders received for the new engines, boilers, &c., for the Chicago waterworks were opened on the 31st March, and found to include the following:—

Henry B. Worthington, of New York, for five triple-expansion four-cylinder vertical engines; each engine, cylinders, 25½in., 42in., and two 51in., 60in. stroke. Four vertical pumps, 34¼in. diam. × 60in. stroke, 110ft. piston speed, 137 million gallons duty guaranteed. Twenty-three boilers, 56in. diam. × 18ft., with four 24in. tubes. Price, $450,000. Also an informal bid for five compound engines. Two 28¾in. high-pressure cylinders, two 57½in. low-pressure cylinders, 60in. stroke, 110 million gallons duty. Price, $380,000.

Quintard Ironworks, of New York, five triple-expansion steam engines; each engine, cylinders, 20in., 32½in., and 56in., 8ft. stroke. Three pumps, 26½in diam., and 8ft. stroke, 256ft. piston speed, 110 million gallons duty. Twenty-two boilers, 57in. diam. × 16ft., with 38 4in. tubes. Price, $625,000.

Edward P. Allis and Co., of Milwaukee, for five engines, triple expansion. Plan A, flywheels on top; each engine, cylinders, 27in., 48in., and 70in., 60in. stroke. Three pumps, 32¾in. diam. × 60in. stroke, 162ft. of piston speed, 125 million gallons duty guaranteed. Fifteen boilers, 62in. diam. × 20ft. long, with 49 4in. tubes. Price, $354,785. The same proposition, plan B, flywheels on floor. Price, $369,785.

The last-named tender was accepted.

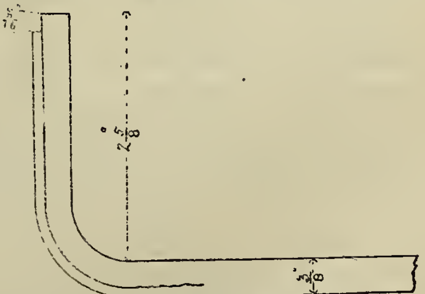
CORRESPONDENCE.

We do not hold ourselves responsible for the opinions of our Correspondents.

THOSE BLISTERS.

To the Editor of "The Practical Engineer."

Sir,—The advent of steel plates for steam boiler construction was hailed, by those interested in the development of that much neglected humble servant but dreaded master, as a great advance over that of iron, for many reasons, amongst which not the least was that now we should have done with *blisters*, so common to all furnaces, even sometimes with that well-reputed "Lowmoor." But such is not the case, as I have found to my surprise and regret. A few weeks ago, while welding and flanging a ⅜in. steel plate from one of the leading steelworks in Scotland, we discovered that one end of the plate was laminated all across, and when we flanged it the outer piece of plate drew upon the inner plate so as to be $\frac{3}{16}$in. shorter, as per sketch, which showed that the opening extended at least to the heel of the flange. When we came to punch it, the "burrs" were in two pieces, one about ⅛in. thick, and the other a bare ¼in., the inner faces of which were as good and smooth as the outer faces.



I thought this of sufficient importance to be named in your practical journal, and I would like to know what is the experience of other boilermakers in this respect, and if steelmakers know how this sort of thing is produced, or how it is to be prevented, as the continued existence of blisters is of great importance to a BOILERMAKER.

Burnley.

HEATED NECKS.

To the Editor of "The Practical Engineer."

SIR,—Your correspondent, "Young Engineer," asks for the experience of some of your readers with heated necks. A little over twelve years ago I took charge of some cotton mill engines; among them a second-motion shaft, with one bearing next to pinion very rough and troublesome. There was a water tap fitted to all the bearings, so that if any of them got hot we could turn a little water on to help to cool them down to working order. We used the best oil we could get, but they would get hot occasionally without any apparent cause. We eased the brasses, but they still troubled us, until we commenced to use anti-friction grease, with a drop of water continually falling on the bearing. After using it for a time the necks and brasses were as smooth as glass, and we could turn the water off all of them except one, and they only required cooling at every two hours. If the water is off, the necks get very warm, and require more lubricant as well as attention. When the water is running on it absorbs the heat and keeps the grease in a heavier body betwixt the shaft and steps. We catch the grease in drippers and use it over again on the same neck, or use it for wheel grease. I had an 8in. footstep to a five-story mill, which was very troublesome before using the anti-friction grease. The washers under the shaft have been working now over twelve years without renewing, and still work cool, but if cleaned out and filled with oil it will get hot until refilled with grease. Some of your readers will say, why use water on the bearings? If they will consider how much more heat a pound of water will absorb than a pound of grease, and the difference in price, they will find the cash balance very much in favour of a judicious use of a little water mixed with the lubricant. I have tried to use water on necks with oil, but found it carried the oil off and left the shaft dry, and induced it to wear. There is no doubt the cause of many large necks getting hot is the lubricant not getting on to every part of it, through having oil holes too small; then the neglected part gets hot and expands, and carries all the load until it has either bedded into the step or got equally hot all over. When once a shaft has got rough it requires a little extra attention. It is very different dealing with large journals than small ones, the expansion being so much greater. There is no doubt hot necks have a good many broken wheels to answer for, particularly when geared underside on an upright, as when the shaft expands, if the cogs are shouldered the teeth are pushed too deep in gear; then out come a few cogs without a cause being found.—Hoping the above may be useful to "Young Engineer," I am, yours truly,

ANTI-FRICTION.

THE STEAM ENGINES AND BOILERS BILL.

To the Editor of "The Practical Engineer."

SIR,—Many letters have of late appeared in your excellent journal on the above subject, and on the kindred one of certificates for enginemen, and, with your kind permission, I will add one or two remarks on the subject.

Independent of the question as to whether or not legislation on the subject of boiler inspection is necessary, I think that if such legislation does take place it should begin at the beginning, and I do not consider that the proposed bill does that, inasmuch as it (the Boiler Inspection and Registration Bill) contains no provision or clause specifying that every boiler shall be so constructed as to afford reasonable means of access for the examination of the various parts, and, where brickwork or other external flues are involved, that these shall be of sufficient size to enable an examination of the parts exposed to the action of the products of combustion to be made. Therefore it still remains possible for boilers to be set with flues through which no person can pass, in which case the compulsory inspection becomes a dead letter, unless compulsory periodical removal of all brickwork is also stipulated—an alternative almost too awful to contemplate.

And now a word on one or two remarks contained in the letter signed "Ignorance," in your issue of May 4th. He says corrosion and deterioration ought to be put down to the ignorance of the attendant, but he does not say by whom. I think it would be the greatest ignorance in the vast majority of cases if this were done. Take, for instance, a case where corrosion occurs, and the attendant (not being ignorant in this case) discovers and reports it to his superior, chief engineer or owner, as the case may be, with the necessary intimation that the parts affected are naturally suffering a loss of strength, &c. In pursuit of a niggardly policy, or perhaps from sheer apathy, the said owner neglects to take the necessary steps to arrest the corrosion, and consequent deterioration, until either an accident occurs or expensive repairs become necessary. Would "Ignorance" still persist in laying the blame on the attendant? Neither ignorant nor learned attendants can prevent deterioration from either corrosion or any other cause, unless they are provided with the necessary antidotes for the evil complained of, "and thereby hangs a tale." It is much more a question of £ s. d. than ignorance of attendants that is to blame for corrosion and many other forms of deterioration.

With regard to the remarks, *re* article on "Dry Seasons," I do not see that such cases would necessarily be prevented by the presence of "competent" men; in fact, I should like to know how "Ignorance" knows that there were no competent men at the places where the cases mentioned in that article occurred. It is not impossible that after all there may be at one or more of these places men in charge of the steam power, as "Ignorance" calls it, who, to use his own words again, can see further through a "half-inch steel plate than nine-tenths of the inspectors" (which, I think, is a phrase open to much criticism, for why a half-inch steel plate in particular! Is a half-inch steel plate more transparent than one $\frac{7}{16}$in. or $\frac{5}{8}$in., or than an iron one of any of these thicknesses?), and should therefore be able to adopt remedial measures, almost without the necessity of seeing the interior of the boiler.

In the sneering remarks concerning a so-called entire examination of a boiler, in which the flue examination only extended to the bridges, "Ignorance" gives no particulars which might assist in forming an opinion on the merits of the case, but contents himself with an imputation on the way in which the *hero of the hand-bag* discharged his duty, and a half-implied charge of recklessness on the part of the insurance company.

With regard to the necessity for men to possess certificates of competency, I am strongly in favour of those who have charge of engines and boilers being granted a certificate by competent, practical examiners, and that it should be compulsory for the owners of engines and boilers to employ only such certificated men. Much has been made of the questions, what is to be done with competent, practical men, who would not pass a Board of Trade examination, and the case of owners of small boilers, who require one man to perform miscellaneous duties. These are difficulties only in appearance. The competent, practical man need not be disturbed beyond being asked for a proof that he is a competent, practical man, in the shape of length of service, or by evidence of past or present employers of the successful discharge of duties in the capacity of engineer, and a few impromptu questions by the examiner on matters in connection with the every-day working of engines and boilers. The owner of a small boiler—one, for instance, in farming operations—need not be so seriously inconvenienced as some would have us believe. The examinations instituted would necessarily be for certificates of various degrees of competency. Surely no one expects such an absurd thing to be enacted that the man who for the time being aspires to the position of driver of a portable engine for thrashing purposes, &c., shall be compelled to possess a certificate of the same value as that held by the man who has charge of the engines and boilers of a manufacturing concern, perhaps to the extent of 1,000 i.h.p.; but that is no valid reason why the former should have the opportunity of locking down the safety valves of a boiler, or of running it with no water over the furnace crown, without first giviug some satisfactory evidence that he is cognisant of the principal risks and responsibilities of the position he is undertaking. Altogether, I consider that the system of certificated engineers is preferable to the present one, which allows a firm to induce a man to leave a situation to re-engage with them, and after working at a merely nominal salary (when hours are considered) for, perhaps, a couple of years, until all is got into good running order, and the working expenses brought down to nil, to get rid of him, by not actually discharging him, but by making his position so uncomfortable by the thousand-and-one means available, that he is compelled to seek "fresh fields and pastures new," in order that his place may be filled, at a still lower rate of wages, by some convenient wielder of the shovel or oil-can on the premises, who struggles on through various difficulties until the repairs, coal consumption, &c., become so glaringly heavy that the proprietors decide that it is time to recommence at the beginning of the programme. This is not merely a suppositious case. I know it to be a fact that this kind of thing is systematically carried on, and that, too, by firms deemed reputable.

I could say much more, but have already trespassed a great deal too much on your valuable space, and apologise for the length of what I intended to have been only a short note.—Yours truly, J. S. S.

May 7th.

THERMO-DYNAMIC ANALYSIS OF THE GAS ENGINE.

To the Editor of "The Practical Engineer."

SIR,—The diagram given on page 214 simply emphasises the fact that the atoms which seek to combine cannot get at each other. Not only does the nitrogen act as a diluent, but every molecule of H_2O or CO_2 also dilutes the mixture, and in presence of the dilution the free atoms cannot combine. As to agitation, I think Mr. Guthrie very much under-rates that which actually takes place, and over-rates also the importance of agitation. There cannot be much rest when the mixture, as at present, is drawn in, compressed, exploded, expanded, and exhausted in about two seconds. If agitation such as this gives unsatisfactory results, what would the agitation have to be to give satisfaction? Besides, with the gases completely mixed previous to ignition, a movement almost inconceivably small would bring the required atoms into contact, supposing agitation to be the chief requirement.

As Mr. Guthrie shows, it is best to have nothing to do with the dissociation theory until its exponents have something better than guess-work to offer us. Is it impossible that some may not apply a similar remark to Mr. Guthrie's engine itself, concerning which, and in the absence of other information, the following deductions and questions arise: His patent of "a year or two ago" is apparently abandoned, but why? If the method, though patented, has not been tried, why tell us of it? If tried and successful, why abandoned? If unsuccessful, why described? If it has been at work, what were the results? If not at work, why should a pure supposition be given to us to investigate? As in his engine he has a white-hot cylinder (nothing less will light the mixture), the object of a cool injection of mixture is not apparent. Will the cylinder not require a water jacket, as it will certainly be heated by the hot piston? As to the cool injection, we know that air when compressed gets hot; that if, while compressed, it is cooled to the atmosphere and allowed to rush out, it issues cold. If it is this cold jet Mr. Guthrie uses, he must know that previous cooling cannot be dispensed with, whether the cooling be done with water or by radiation. If by radiation, his cooling surface must be enormous. In any case, where is the gain over a water jacket round the cylinder? I presume that Mr. Guthrie is able and willing to clear up these points, or he would not have given his paper to the world? Should he clear them up, he will be presenting practical men among your readers with an engine which will rapidly make their fortunes, though it seems unfair that its inventor should thus throw away his reward.—Yours, &c.

May 5. W. A. Carlile.

QUERIES AND REPLIES.

Portable and Traction Engines.—Can any reader inform me whether traction and portable engines are manufactured in any of the following countries: Norway, Sweden, Denmark, Holland, Italy, Switzerland, Mexico, Canada, or in any of the States of South America, or anywhere in Australasia? Or can anyone inform me whether there is any modern geography, directory, or other book published which would give the desired information?—W. A.

Splicing Ropes.—Will any reader kindly inform me what are the most modern methods of splicing ropes for working on pulleys, and do those methods labour under any disadvantages?—R. L. F.

Expansion Gear.—Who are the makers, and where can I get a description of, Powell's automatic expansion gear?—Learner.

Scaling Shell Forging.—What is the best mode of scaling the interior of a forged shell? It is partially punched in forcing into shape.—Cort.

Sensitised Paper.—Would some reader kindly give me the names of the chemicals and proportions of the solution for coating paper for taking copies of tracings by the same method as printing photos from a negative?—Surface Table.

Tempering Snaps.—Which is the best method of tempering snaps for ⅞in. and 1in. rivets?—Blacksmith.

Setting Locomotive Slide Valves.—Would any reader inform me of the usual method of setting locomotive slide valves?—Ignoramus.

Copper Boiler.—Could any reader inform me what would be the most suitable kind of copper boiler, with fire box, for 2½in. by 3½in. stroke horizontal engine, to be heated by a lamp or otherwise, and what would the dimensions be?—F. W. T.

Hot Gases.—Would "W. A." or some other reader be good enough to inform me as to the best means of drawing a portion of the hot gases away from the base of a chimney or shaft, through a series of vessels, and discharging the said gases at a temperature of about 260° Fahr. into the atmosphere? I would also like to be informed as to how I could manage to separate the soot, &c., from the gases before entering the vessels, so that there might be as little sooty deposit as possible.—X. B. I.

Winding Engine.—Will some reader kindly assist me by working out the following: What will be the dimensions of an engine, with two cylinders, capable of raising 400 tons of coal per day of nine hours, from a drift 600yd. long, dipping 11in. per yard, working eight trams each journey, weight of each tram 9cwt., and coal in each tram 35cwt., making a total weight of tram and coal=44cwt.; pressure of steam 40lb. per square inch; size of rope ⅞in. diameter; drum 5ft. diameter, and 18in. between flanges.—Antipodes.

Compounding.—We have a pair of high-pressure engines which we want to make compound by changing one cylinder. Will some reader say what amount of condensing water per minute will be required, and the size of pond; also what is the best automatic cut off for D valves? The cylinders are 14in. diameter by 24in. stroke, and make 83 revolutions per minute; cut off at 10in. Boiler pressure 60lb., but not more than 50lb. on the piston. Port opening 6¾ by ⅝.—J. A.

TO CORRESPONDENTS.

J. A. L.—There are none that we know of. See Willis's work on mechanism.

Sphere.—The reason is that the strength is the same in every direction. A cylindrical boiler is twice as strong transversely as longitudinally.

P.—Any engineer's notebook will give the dimensions of these threads.

F. W. B.—The pressure at the nose of the diagram just before opening to the exhaust is measured, and, the distance the piston has travelled up to that point being known, we have a known volume of steam at a known pressure, and therefore by means of tables we can find the weight. This is, of course, the weight of steam discharged per stroke, from which can be calculated the amount used per i.h.p. per hour.

Gas Engine.—Apply to the Ontaria Pump Company, 25, Gunter Grove, Fulham, London, S.W.

Marine.—See the very full answer we gave to this same question in our issue for March 9th.

Anxious.—Your answers are quite correct. No. 4 seems a little ambiguous, but we think you have answered it in the right way.

J. A.—The communication is not suitable.

Exell.—Your address will be forwarded as required.

Beginner.—The top of the wheel travels quickest because it is furthest from the fulcrum.

MISCELLANEA.

Employers' Liability Bill.—In reply to Mr. Burt, Mr. W. H. Smith said: "I have every hope that the Employers' Liability Bill will be read a second time before Whitsuntide."

Lake Aboukir.—The drainage of Lake Aboukir, by centrifugal pumping machinery supplied by Messrs. J. and H. Gwynne, of Hammersmith Ironworks, London, is now completed, the lake having been pumped dry in 456 hours with an expenditure of 135 tons of coal.

Drop Forgings.—Drop forgings, for almost every conceivable purpose, are very popular in America. The smallest forging at present made by one firm at Hartford is used on a type-writer, and weighs one-sixteenth of an ounce; the heaviest is the connecting rod of the Westinghouse engine, and weighs 40 pounds.

Large Hailstones.—There has been a terrible hailstorm at Delhi and Moradabad, in the North-west. Hailstones have been picked up weighing 2lb., and most of them were flat and oval in shape. One hundred and fifty persons are reported to have been killed chiefly by the hailstones. The natives who were in the open air were half frozen by the cold wind, and then killed outright by the hailstones.

Glasgow and the Exhibition.—"Glasgow has been undergoing a spring cleaning in view of the Exhibition," says the *Scottish Leader*. "If you step out into the road, you either fall down an open drain, or wander amongst piles of paving stones, or trip over scattered tram-rails, or stick up to the ankles in warm asphalte, or are blinded, choked, and spat upon by an infernal machine for melting pitch, or are chased round a church by an infuriated steam roller."

Traction Engines.—The Chancellor of the Exchequer, answering Mr. Knatchbull-Hugessen, explained that according to his intention in framing the proposals of the Excise Duties (Local Purposes) Bill, licenses would not be required for steam ploughs, thrashing machines, or any other implements used solely in agriculture; but locomotives and traction engines used on roads would be liable to the license duty.

An Expensive Reservoir.—The reservoir at Padiham is likely to prove an expensive one. The contract was let five years ago for £29,517, and the work was to be completed at the end of October, 1886, but the nature of the ground caused delay, and seriously added to the cost. Up to the 25th of March last there had been expended on the waterworks £43,903 15s. 11d. The estimate for the completion of the work is £33,849; and the Local Board of Padiham are now applying to the Local Government Board for powers to borrow an additional £32,000.

Owens College: The Professorship of Physics.—Professor Arthur Schuster, Ph.D., F.R.S., has been appointed to the Langworthy professorship of physics and directorship of the physical laboratory at the Owens College, in succession to the late Professor Balfour Stewart. The chair of applied mathematics is consequently vacated by Professor Schuster. We understand that in future the whole of the mathematics (pure and applied) at the college will be under the charge of Professor Lamb.

Water-Gas.—Under the title of the Gaseous and Liquid Fuel Supply Company, Limited, a company has just been registered to take over the patents of Mr. B. H. Thwaite, C.E., F.C.S., of Liverpool, for generating water-gas, and other descriptions of gaseous fuel, for gas motors, gas furnaces, and for heating purposes generally, and for the application of Mr. Thwaite's patents for heating and lighting with liquid hydrocarbons. The company will establish a fuel-testing laboratory, and act as guarantors against smoke-nuisance fines. The objects of the company in effecting fuel economy and preventing smoke are likely to be a public advantage.

Manual of Phonography.—A new edition of the well-known Manual of Phonography has been issued by Isaac Pitman and Sons, which has been thoroughly revised, and now contains all the latest improvements in style that have been suggested by long experience. We hope the new edition will have an increasing sale. The same publishers have also issued a manual of the type writer, by John Harrison, which contains very useful instructions on the method of using this valuable instrument.

Electrical Winding Ropes.—At the Newcastle Exhibition was shown a working model of an invention by Mr. Armstrong, of the Wingate Grange Colliery, Durham, by which a means of communication is afforded between the occupants of a colliery cage and those on the surface at any moment of its progress up or down the shaft. All that the inventor does is to have woven in the core of the winding rope, at the time of manufacture, an insulated wire. Vyle's easily tested lightning conductor, invented nearly ten years ago, is on precisely the same plan. Steel winding ropes, with the insulated wire enclosed, are manufactured by Messrs. D. H. and G. Haggie, of Sunderland, who are inclined to think that hawsers made on a similar plan would meet the requirements of telegraphic communication with lightships and lighthouses.—*Electrical Review.*

Messrs. Gresham and Craven, of Salford, have recently introduced a patent steam sanding apparatus for locomotives, by which the driver is enabled to sand the rails in a really efficient manner. By this apparatus, which is very simple in its application, sand is projected by a steam jet directly and instantaneously to both wheels, and there is a perfect gradation in the delivery, whilst the working is not interfered with by wind or weather. With this appliance in use, it is claimed that coupling rods may be dispensed with, and that a single engine thus fitted up will have as much adhesion as a coupled engine without it. The apparatus can be applied to the present sand-boxes without any alteration, and the simultaneous delivery of sand at the point of contact for both wheels materially reduces the liability to injury in the crank or driving axles and coupling rods. Many of the home, colonial, and continental railways have already adopted this sanding apparatus.—*Engineer.*

Engineering Society, King's College, London.—At a general meeting held on Tuesday, May 1st, Mr. A. H. Preece delivered his presidential address. He took for his subject the question of electric lighting from central stations, and described the following systems: (1) The direct parallel as still used in the Edison system in New York; (2) The three-wire system used by Edison in America and patented by Dr. Hopkinson in England; (3) The direct multiple series proposed by Bernstein; (4) Distribution by means of alternate current transformers; (5) Distribution by means of secondary batteries, as adopted by Crompton, at Kensington Court; (6) Distribution by means of continuous current transformers. He then proceeded to compare the system of tranformers and that of secondary batteries, and concluded by stating the various charges to consumers made by the different electric light companies in England. After a vote of thanks had been passed to Mr. Preece the meeting adjourned.

The Bar-lock Type-writer.—An improved form of type-writer, which is an advance upon its predecessors of the type-bar class, has just been brought out. In this machine the type-bar on falling is locked, thus securing perfectly even alignment. The types impinge upon the paper on the top of the paper-carriage, so that the writing is visible to the operator as the work proceeds. The keyboard is in duplicate—that is, there is one board for capitals and another for small letters, the letters in both being similarly arranged. Hence there is no loss of time in having to hold down a shift key when capitals are required, as in some machines. The paper-carriage shifts to the next line automatically, and the working of the machine is simple and light, giving consequently great rapidity of production. The ink-riband is caused to travel as the writing progresses, so that a fresh spot is presented to each type. There are various other improvements in detail which render it a useful commercial machine.

A Raft with Six Masts.—The loss of the great raft formed of 27,000 trunks of trees, of which a description has been given, does not deter the Americans from making another. They are now constructing an immense raft, which will be bound together at the two extremities, and will be about 650ft. long by 90ft. broad; it will be provided with six masts and sufficient canvas to enable it to sail to New York without assistance from steam. According to the last accounts, which are dated the 15th of March, Saint John, New Brunswick, this raft is already half completed, and will be launched in the month of July next. The pieces of wood of which it is composed are the largest that have yet been sent from New Scotland, and the value of the raft will be about £9,000, that is to say much greater than the first. The season chosen for the voyage being more favourable, there is reason to hope that this raft will be more fortunate than its predecessor, and will arrive in good condition, relieving its proprietors of the enormous expense they would have to incur if obliged to transport the wood by means of the schooners which are usually employed for this kind of transport.

SELECTED PATENTS.

APPLICATIONS FOR LETTERS PATENT.

April 27th.

6252 Locomotive and Marine Engines, E. A. Jefferies, London.—[Complete Specification.]
6259 Valve, A. H. Chartres, London.
6262 Mules for Spinning, W. Knowles, London.
6263 Drying Cylinders, A. J. Entwisle, of the firm of T. Entwisle and Son, London.

April 28th.

6288 Fire-boxes of Steam Boilers, H. Foster, Newcastle-on-Tyne.
6296 Radiators, J. G. Wagstaff, Manchester.
6297 Friction Clutches, W. Kenyon, sen., W. Kenyon, jun., G. H. Kenyon, and E. Kenyon, of the firm of W. Kenyon and Sons, Manchester.
6298 Nut Locks, J. B. Atherton, Leeds.
6306 Couplings, J. South and W. Bursch, Paris.—[Complete Specification.]
6310 Belting, J. Holland and J. Lever, trading as the Yellow Star Company, Manchester.
6314 Dynamo-electric Machines, J. P. Hall, Manchester.
6320 Vacuum Brake, J. Gresham, of the firm of Gresham and Craven, London.
6322 Galvanic Batteries, P. R. de Faucheux d'Humy, Middlesex.
6326 Manufacture of Iron, A. G. Greenway, London.
6334 Machines for Making Nails, H. H. Leigh, Middlesex. (R. Liefmann, Germany.)
6346 Purification of Gas, S. Chandler, junior, and J. Chandler, London.
6352 Purification of Water in Boilers, H. T. Yaryan, London.—[Complete Specification.]

April 30th.

6373 Electric Batteries, L. Dill, Germany.
6378 Machinery for Cleaning Metal Plates, A. E. Hiles, Llanelly.
6384 Safety Brake, W. H. Graham and G. R. McDonald, London.
6389 Composition for Covering Steam Boilers, S. P. Moon and J. Oswald, London.
6390 Electrical Switches, W. Mackie and S. Sharp, London.
6392 Furnaces, W. P. Thompson, Liverpool. (E. T. Van Hecke and V. C. Laurent, France.)
6397 Safety Lock, C. Arnheim, London.
6411 Pipe Joints, F. J. Maule, London.

May 1st.

6415 Gas Pressure Regulators, C. Westphal, London.
6419 Governing Steam Engines, F. J. Burrell, Norfolk.
6425 Lock Nuts, J. R. Hargrove, Birmingham.
6431 Lock Nut, H. Bezer, Surrey.
6432 Gaseous Fuel Producing Apparatus, B. H. Thwaite, Liverpool.
6434 Type-writers, H. McGrady, Glasgow. (L. S. Crandall, United States.)
6435 Lubricator, W. Martin-Epton, Leeds.
6438 Coupling Carriages on Railways, F. Groves, Manchester.
6441 Lubricators, &c., J. K. Clarke, Ipswich.
6442 Pipes, J. Illingworth, Halifax.
6445 Type-writing Machines, B. Granville, London.—[Complete Specification.]
6448 Valves, B. Rhodes, London.
6464 Tables for Band-sawing Machines, E. Whibley, London.
6465 Propellers, J. M. Hale, London.
6468 Engines, Konrad von Kortynski, London.—[Complete Specification.]
6473 Screw Vessels, W. P. Thompson, Liverpool. (W. T. Sylven, United States.)—[Complete Specification.]
6475 Valves for Steam Engines, A. J. Boult, Middlesex. (A. Tolton, Canada.)
6481 Electrical Transmission of Power, H. H. Lake, London. (N. Tesla, United States.)—[Complete Specification.]
6484 Blowing Engine, C. Davy, London.
6485 Type-writing Apparatus, F. Wilkins, London.
6487 Centrifugal Apparatus, G. F. Redfern, Middlesex. (T. T. A. Hansen, ———.)—[Complete Specification.]
6490 Hydraulic Engines, R. Wright, London.
6491 Tanning, H. Levic, London.
6494 Roller Mandrels, S. P. M. Tasker, London.—[Complete Specification.]
6502 Generation of Electric Currents, H. H. Lake, London. (N Tesla, United States.)—[Complete Specification.]
6505 Generating Steam in Boilers, F. W. Cannon and G. P. Addison, London.

May 2nd.

6510 Moulding Machines, S. Smith, Smethwick
6514 Gas Producers, A. Wilson, London.
6524 Apparatus for Galvanising Wire Netting, C. Wilcox and H. Smith, Birmingham.
6526 Door Lock, C. D. Richards, Bristol.
6534 Brake Apparatus for Railway Vehicles, E. Bottomley and J. Day, Bradford.
6536 Trip Motion for Corliss Valves, G. G. Rhodes, of the firm of Rhodes and Critchley, and F. W. Bywater, of the firm of Bywater and Nephew, Yorkshire.
6544 Coupling Railway Vehicles, J. Moore, London.
6549 Railway Brakes, F A. Holleman, London.—[Complete Specification.]
6565 Lubricators, R. Brigham, London.
6571 Gas Stoves, W. Garland and W. T. Crooke, London.
6573 Steam Traps, J. Wrigley, Liverpool.
6578 Incandescent Electric Lamps, J. Y. Johnson, Middlesex. (C. Philippart, France.)
6585 Springs, H. Wilkins and A. A. Booker, Yorkshire.
6586 Testing the Soundness of Traps, J. R. Shelton, Sussex.

May 3rd.

6594 Lubricating Machinery, R. Sleading, Clitheroe.
6597 Couplings and Brakes, E. Shaw and G. J. Harcourt, London.
6602 Pipes, J. F. N. B. Simons, Middlesex.
6604 Machinery for Twisting Thread, P. Smith the younger, of the firm of P. Smith and Son, and S. Ambler, London.
6609 Mechanical Telegraphs for Navigable Vessels, W. Chadburn, Liverpool.
6613 Resistance for Electric Light Circuits, S. Miller, London.
6618 Moulds, J. Jackson and E. E. Jackson, trading as G. Jackson and Sons, and C. K. Falkenstein, Clapham.
6621 Steam Boats, C. H. McEuen, of the firm of McEuen and Co., London. (N. Selfe and H. Selfe, New South Wales.)
6622 Draught Regulators in Furnaces, C. Laszgallner and A. Nöhring, London.—[Complete Specification.]
6627 Electric Lamp, G. A. Tabourin, London.
6631 Hoisting Apparatus, L. Mégy, London.
6637 Locking Fish-plate Bolts, H. E. Robinson, London.

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EDITORIAL NOTICES.

All communications for the Editor of this Journal should be addressed to 6, Victoria Station Approach, Manchester.

Communications intended for insertion in the current week's issue should reach us not later than Tuesday Evening.

We cannot undertake to return rejected manuscripts or drawings unless accompanied by a stamped and directed envelope.

Contributors are requested to write on one side only of the paper. Sketches should be sent on separate sheets.

TO ADVERTISERS.

Advertisements intended for insertion in the current issue should reach us on Wednesday morning at the latest.

THE
PRACTICAL ENGINEER.
MAY 18TH, 1888.

A REMARKABLE ENGINE RUN.

A FORTNIGHT ago we referred in a paragraph to a remarkable run achieved by a Westinghouse engine. The engine, which is described as a 10 h.p., ran for thirteen months at a speed of 500 revolutions per minute without stopping, and in that time the total number of revolutions made would be about 288,000,000. This is the longest run ever recorded, and we have no doubt that it has never been surpassed by any engine ever made. Besides the merely curious side of this steam engineering feat, there is something to be learned from it, and engine builders might add something to their stock of knowledge by thinking over the conditions that must be present for the accomplishment of such a run. To the uninitiated it might appear that a well-designed and well-fitted engine would go on running for any length of time if the bearings were simply kept well oiled; but such is not the case, and the reason for it is to be looked for in the forces that are constantly at work, and which tend, sooner or later, to bring the engine to rest. Engineers are becoming very familiar with the fact that a beam cannot be continually bent first in one direction and then in the other by a force ever so small without in time giving way altogether; and here, then, we see the first force that would in time bring the engine to rest, for the crank-shaft is acted upon by a variable force which has a maximum and a minimum twice every revolution, and the ultimate effect will be, providing nothing else has given way first, that the crank-shaft will succumb to the variable stress acting on it. That the crank-shaft of the Westinghouse engine should have withstood 576,000,000 such variations proves that it is made of exceptionally good material; and for an engine that is intended to make long runs this must be one of the first things to be seen to.

The connecting-rod and other parts of the engine, even the beds, are also subject to these varying stresses, which tend to produce rupture, but none of these parts are likely to give way from this cause as soon as the crank-shaft, owing to the forces being direct instead of transverse.

The second cause tending to bring the engine to rest is friction, which gradually but surely wears away the bearing surfaces, and in time produces bad fits, which lead to knocking. When knocking of pins or brasses once commences in a quick running engine, every engineer knows that it will not be long before stoppage for repairs must take place. The parts most likely to suffer from this cause are the connecting-rod and crank-shaft brasses. It is necessary that the fitting of these parts should be very accurate, and the alignment also must be exact. Heating, of course, must be avoided, otherwise it is impossible to make a long run, and the secret next to good workmanship turns upon proper and sufficient lubrication. Single-acting engines have a great advantage in regard to this cause, because the thrust is always in one direction, and it should be possible to run an engine of this kind with lead and compression so adjusted that there will be absolutely no knock, and the length of the run would, in all likelihood, be determined by the tenacity of the crank-shaft. The fit of the pistons and valves is very important, but is not so difficult to deal with as the brasses. Another cause which, once it comes into operation, soon causes stoppage for repairs, is slight deformation of rubbing parts owing to knocks, and, as said before, as soon as this disagreeable mentor is heard, it is known that a stoppage is not far distant. The only way to guard against this action is to secure, in the first place, accurate workmanship and fit of all revolving and sliding surfaces.

It will be seen from the above that the forces tending to bring the engine to rest are easily recognised, and can be fought against for a very long time, as is instanced by the remarkable run achieved by the Westinghouse engine, and it also follows from what has been said that it is not sufficient to give plenty of bearing surface for all slides and pins, &c., as is sometimes thought, but that other considerations have to be taken into account in addition. After all, except for very special purposes, it is more than doubtful whether it is worth while going to the trouble and expense of making an engine that will revolve close on 300 million times without stopping.

THE NICARAGUA CANAL.

According to the *New York Herald*, which has had a special correspondent on the scene of the proposed Nicaragua Canal, the great rival to the Panama Canal is being pushed forward in all seriousness, and with every confidence in its ultimate success. We must not, however, suppose that the difficulties that will be encountered in the course of construction will be easily surmountable, although they may not be quite so formidable as those encountered by M. Lesseps. From the reports of the correspondent referred to above, several engineers engaged in the work of surveying have already succumbed to the climate, which fact does not augur well for the workmen who will have to follow. We hear of steep hills in the neighbourhood of the eastern watershed that will have to be cut through, and forests in which the sun is unable to penetrate. Swamps of uncertain depth and attendant malaria indicate the kind of difficulties and dangers that beset the path of the constructors, and from which we infer that the risks are only a degree less than those at Panama. The promoters are still sanguine of ultimate success, and the present workers engaged in the preliminary operations appear in good health and spirits.

SOME PRACTICAL NOTES ON MARINE ENGINEERING.—XIV.

(*Continued from page* 183.)

Design and Construction of Boilers.—III.

FURNACES (*continued.*)

It will be observed from these formulæ that the length of a furnace having corrugations or other closely pitched annular stiffening rings is not taken into account in calculating the working pressure, but in all other kinds the length is an important factor. Notwithstanding the large proportion of special furnaces on the above-mentioned principle now in use, there are a few of the old style successfully at work, and others making for the high pressures. There are also the flanged seams, which are well adapted for 160lb. pressure, and for all these the length must be taken into consideration. Lloyd's formula is $\frac{89{,}600 \times T^2}{L \times D}$ = working pressure, but in no case is the pressure to exceed $\frac{8000 \times T}{D}$

where D = the outside diameter in inches;
T = thickness in inches;
L = length in feet. If rings are fitted, the length between rings to be taken.

The object of the latter, which we may term the limiting formula, is to prevent an excess of crushing stress on the material. Were, however, this formula to be enforced, a well-constructed flanged seam furnace would be placed at a disadvantage as compared with a corrugated furnace; therefore the ultimate stress has been raised to 11,000lb. when the flanged seams are not more than 23in. apart—that is, the ultimate crushing stress is increased from 4,000lb. to 5,500lb. Furnaces made in this way have no joints in the fire, the longitudinal seams being welded. In plain furnaces the ends are welded for a distance of about six to nine inches, and the rest double butt strapped, single riveted. This gives a nice plain ring for fitting into the front plate, and if the back tube plate is flanged a good job can be made and a tight joint ensured. Sometimes the flange of the tube plate is extended right round, then bored out, and the furnace turned in the lathe; the furnace front flange has also been bored out, but it is not often this plan is adopted, on account of the special appliances required to maintain a perfect cylinder while the plates are cooling. Special flanging plant is also necessary, and altogether the work is more expensive, though there is much time saved in the fitting. When the furnace front is flanged outwards, the diameter of the mouth is larger than at the tube plate, and the furnace is tapered slightly. The front end can be riveted up before the furnaces are put in, and, considering the large diameter of the rivets, this is of great importance. The furnaces can then be put in one by one, and riveted up from the inside, where there is plenty of room to work; even when the furnace front is not flanged outwards an advantage is gained by getting the large rivets in first.

The Board of Trade formula is $\frac{90{,}000 \times T^2}{(L + I) \times D}$ and the limiting formula $\frac{8000 \times T}{D}$ the same as before given.

The 90,000 applies to double butt straps, single riveted, as usually used, but the constant is reduced to 60,000 for single riveted lap joints, not bevelled.

By way of example, we give in the following table the thickness of plate required for each kind of furnace—say, external diameter 42in., and 6ft. long, for 160lb.

Lloyd's. Plain Furnace.	Board of Trade. Plain Furnace.	Limiting Stress to 4,000lb.
$T=\sqrt{\frac{P \times L \times D}{89{,}600}}$ $\cdot67=\frac{11}{16}$in. nearly.	$T=\sqrt{\frac{P \times D \times (L-I)}{90{,}000}}$ $\cdot723=\frac{3}{4}$in. nearly.	$T=\frac{P \times D}{8{,}000}$ $\cdot84=\frac{13}{16}$in. full.

Corrugated and Annular Ribbed. Lloyd's.	Corrugated. Board of Trade.	Flanged Seams, Limiting Stress to 5,500lb.
$T=\frac{P \times D}{1{,}000}+2$ $\frac{8\cdot7}{16}=\frac{9}{16}$in. full.	$T=\frac{P \times D}{12{,}500}$ $\cdot5=\frac{1}{2}$in.	$T=\frac{P \times D}{11{,}000}$ $\cdot61=\frac{5}{8}$in. nearly.

It will be observed that the thinnest plate can be obtained with the corrugated and annular ribbed furnaces; next comes the flanged seams, while the plain furnace without any stiffening rings would have to be as much as $\frac{13}{16}$in. thick.

TUBE PLATES AND TUBES.

The tube plates are never less than $\frac{11}{16}$in. thick in small boilers (average thickness about $\frac{13}{16}$in. for three furnace boilers), while in boilers of large diameter, and having wide combustion chambers, the thickness may be $\frac{15}{16}$in. or 1in. The crushing strength of the material, as given by the Board of Trade formula, fixes the thickness thus, $\frac{(D - d) \times T \times c}{W \times D}$ = working pressure.

where c = 20,000 for steel, and 15,000 for iron.
D = least horizontal distance between centre of tubes in inches.
d = inside diameter of tube in inches.
T = thickness of tube plate in inches.
W = extreme width of combustion chamber box in inches from front of tube plate to back of fire box, or distance between combustion box tube plates (when boiler is double ended), and the box common to the furnaces at both ends.

For example, take a double-ended boiler, as shown in sketch fig. 9, page 564, Vol. I. *Practical Engineer*, where the box is about 40in. wide, say $3\frac{1}{2}$in. tubes, No. 8 B.W.G., pitch $4\frac{3}{4}$in. between centres, pressure 160lb.; then by above formula

$$\frac{P \times W \times D}{C \times (D - d)} = T = \frac{160 \times 40 \times 4{\cdot}75}{20{,}000 \times (4{\cdot}75 - 3{\cdot}16)} = {\cdot}95, \text{ or say } 1\text{in.}$$

The tubes are from $2\frac{3}{4}$in. to $3\frac{3}{4}$in. diameter – 9 to 7 B.W.G., swelled $\frac{1}{8}$in. at one end and expanded into each tube plate. The stay tubes vary from $\frac{3}{16}$in. to $\frac{3}{8}$in.; they are screwed into each tube plate and beaded over. Nuts are seldom fitted, and, from experience gained with a large number of high-pressure boilers, it has been proved that they are quite unnecessary, except on the outside rows, where the flat unstayed area may be large.

Although the plain tubes afford a large amount of resistance to the bulging of the tube plates, they are never taken into consideration as stays, and all the strain is referred to the screwed stay tubes, the thickness of which is made accordingly. And again, owing to the expansion and contraction and consequent leakage that might ensue, the area of the tube holes is never deducted in estimating the distance apart of the stay tubes, but the tube plate is considered as a plain flat surface.

Tubes are made of iron or steel (the plain ones are occasionally made of brass); they are what is usually termed lap-welded. The process of manufacture is a very interesting one, and can be easily followed from the commencement to the finish. The plates are delivered the right size, according to the dimensions of the tube. An allowance is made on the width for the lap, and also on the length, for drawing out while welding. They are made in lengths, ranging from 14ft. to 22ft., and afterwards cut as required; thus, 7ft. tubes would be made 15ft. to 16ft. long, and cut in two.

The plates, as delivered, are first passed through a machine, and bevelled on the edge. The tools are stationary, and the plate is drawn along by means of a grip, attached to an endless chain. Once through the machine, and they pass on for the first heat. From this furnace they are pulled—again by means of a grip and endless chain—through a die, and thus made round and lapped ready to be taken to the welding furnace, where they are heated full length to a welding heat. This is the most difficult part of the manufacture, and great care and skill are required on the part of the welder in order that the tube may be of the required heat—too cold, and it would not weld; too much heat would spoil the material; and to have them placed in the furnace and taken out as wanted requires great experience.

LITERATURE.

Asbestos: Its Production and Use. By R. H. Jones. Price 1s. London: Crosby Lockwood and Son.

The uses to which the mineral asbestos can be and is now put are astonishing, and as its properties become better understood by engineers and architects we shall see a wide extension of its use. In the little pamphlet before us, which has been compiled from a series of letters originally written to a friend, the author very clearly enumerates the properties and appearance of the many varieties of the mineral, but speaks more particularly of the Canadian variety, with which he has had most to do. Our readers are well aware that the two countries producing asbestos in the largest quantities are Italy and Canada, and to some extent they are rival producers, but it is safe to say that each variety possesses qualities that make it specially applicable to certain purposes for which the other is not so well fitted, and therefore when greater experience has been gained of the merits of both we shall undoubtedly see that each variety will find its proper place. The author gives a full account of some of the best known asbestos mines in Canada, and the method of working them, and in the last division of the pamphlet enumerates some of the uses to which the mineral can be put. Engineers who wish to know something about asbestos cannot do better than consult this very readable little book.

MOULDING and CASTING OF CYLINDERS.—II.

By a Practical Man.

(Concluded from page 207.)

In my previous contribution I endeavoured, in as practical a manner as possible, to give in detail the various operations necessary in making the mould. That being done, I will now deal with the closing and casting of the same, which undoubtedly is the most intricate part of the whole job. Indeed, it is no unusual thing to see in foundries men kept specially for the closing of moulds prepared by other men; but although this practice may facilitate the pushing forward of the work, yet, in my opinion, every moulder should be able to close his own work.

Immediately on taking the mould from the stove, the moulder's first duty is to see that it is thoroughly dried before proceeding with the closing. He should be satisfied that when casting it there will be no blowing from the damp which invariably gathers from moulds that are not properly dried. But should there be an urgent necessity to proceed with the casting in the face of these adverse circumstances, the mould should remain open as long as possible, so that it may be comparatively cold before the "top part" is put on.

To come more directly to the point of closing, the greatest care must be exercised in securing the cores with the chaplets after the thicknesses have all been adjusted, which very often is the means of saving much time and trouble; for to unfasten a core that has once been secured or jammed frequently ends in some part of the mould or core being displaced or broken; hence the necessity of having the thicknesses all properly adjusted before jamming. The next thing to be attended to is the securing of the vents, which cannot be too carefully done, as there is nothing more depressing to a moulder than to see his whole work going to destruction before him through lack of proper vents to allow the gases to get away freely from the cores, thus causing a bad casting, which might have been averted by the exercise of proper care. With cylinders that have the steam chest or casing cast on them, it is necessary for the gas from the ports and exhaust to pass through the heart of the casing core. The simplest manner of venting in this case is to daub the joints of the above with white or any other suitable loam; then clear the vents of the ports and exhaust, fill the heart of the casing with fine ashes, and conduct the entire vent through the joint of the boxes, or pass it up through the casing bearing in the "top part."

There is great diversity of opinion amongst engineers as to the position of casting cylinders; some inclining to cast them vertically or on end, others to cast them horizontally. The majority, I believe, favour the former plan, maintaining that in the horizontal position the dirt sticks about the barrel and creates a faulty bore. But in the other case of vertical casting there is the universal complaint of bad flanges on the top or gate end of the casting, which only comes to view when the sinking-head is cut off. These imperfections are created during the process of solidification of the metal in the mould, which continues till the fluid metal is thoroughly set. These cavities are always greatest on cylinders that have a disproportionate thickness, as it is seldom, if ever, a plain barrel is thus affected. Now, the best thing that can be done for this is to "feed" the casting as long as the metal is fluid; but unless provision is made for the feeders, the feeding will be useless; consequently the sinking-head must be made heavier, so that it may be the last part to solidify. The advantage of keeping the sinking-head fluid until all the other parts are set is apparent, as if it be thus kept fluid, and the casting fed, these drawn holes will be in a great measure diminished, if not entirely removed, when the cylinder is cast on end. Should the disproportionate thickness of metal be confined to one side of the cylinder, such as is the case with locomotive cylinders, where the framing flange is on same side as the valve-face, it is much better to confine this extra thickness in the sinking-head to that side only, as it is about these parts that the mischief is wrought. Having thus formed a heavier sinking-head, it admits of heavier flow-gates being made, which gates should be made about twice the thickness of the metal in the barrel of the cylinder. Let it be remembered that the only preventive against cavities is compression and feeding well. In passing I may mention that the heavy flow-gates must be put on the parts most likely to "draw." I remember seeing a small cylinder cast on end three consecutive times bad, each time the casting being spoiled by having blown holes on the valve-face. The fourth time it was cast horizontally, and it turned out a first-rate job. I believe that I am within the mark when I say that of cylinders cast vertically there is a loss of 20 per cent through these drawn holes on the top flange. Now, when cast horizontally, this perplexing evil is completely done away with. Still those prejudiced against this mode of casting will raise the question of the barrel being dirty, but there is little fear of this provided the mould is run in a proper manner. In casting horizontally the gate pin can be placed at either end of the barrel, rammed up in the top part (of course the same to be drawn before parting the box). When finishing the mould, cut the gate or gates on the extreme bottom of the drag-bearing, and make them sufficiently large to run the mould in due time. This running by the bottom of the barrel bearing sends the dirt right up to the extreme top of the mould, and, consequently, clear of the inside of the barrel. Avoid, at all times, the cutting of the gates from the parting or the joints, for to do so the dirt that gathers about the bottom of the mould in closing will never rise to the top, but will stick to the bottom of the core, and make the barrel on the bottom side full of small holes or speckles, thus rendering the casting useless.

I will close with just a hint as to the metal. It is useless to specify any particular brand or brands, further than to say that any ordinary brands, suitable for general engine castings, will suffice, but on no account will it do to use raw pig-iron, as it is too soft. The best quality is good clean scrap, such as loam plates, &c., if composed of ordinary metal used for general engine castings. When this cannot be got, the raw pig-iron should be run into bars suitable for breaking up, as it is very important that the metal should be strong, clean, and hard.

In regard to the heat, we may remark that some moulders think that the metal cannot be too hot; nay, some are of opinion that the metal must be a milky white when poured into the mould. This, however, is altogether a mistake, as the best cylinders I have seen were got from metal that had lost its fiery life, and showed a nice undulating surface before casting.

I hope that a perusal of these remarks may be of interest to the experienced and inexperienced alike, as there can be no doubt there is a great want of literature to assist the young moulder forward through the difficulties of his vocation. There is no denying the fact that if moulders would study the intricacies of their trade they would be better men for themselves, and infinitely superior workmen for their masters.

AN ENGINEER'S LIFE AT SEA.—VI.

BY A SEA-GOING ENGINEER.

[Continued from page 195.]

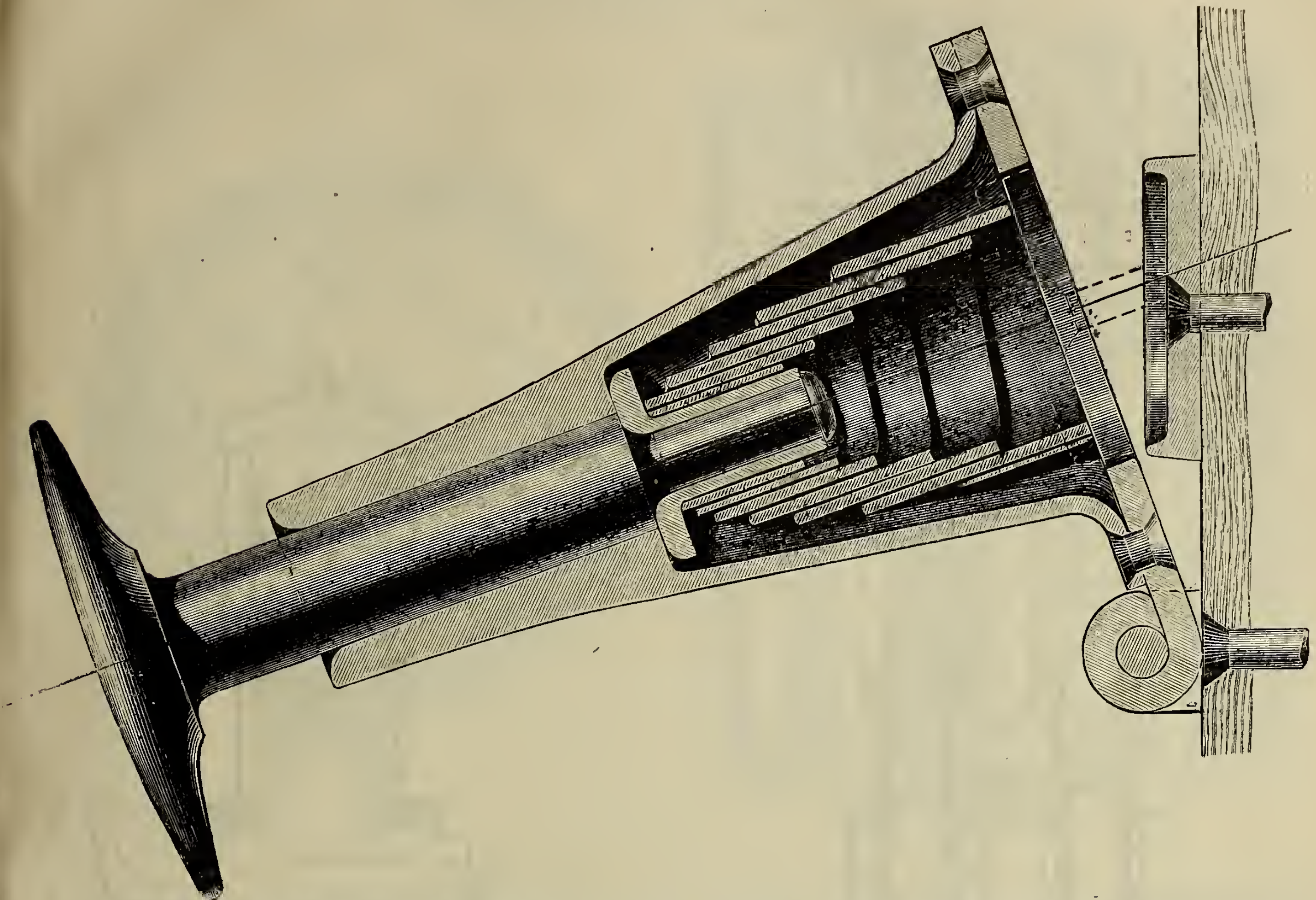
BREAKDOWNS, unlike other of life's trials, must always be met more than half way, for the skill which keeps an engine running smoothly is quite as valuable as that which can readily repair damage done. When on watch, every sense must be on the alert. The practised ear distinguishes the slightest variation in any of the numberless noises in the engine-room, and this alteration of sound is usually the first, sometimes the only, warning of anything wrong. By the sense of touch the heating of working parts is readily detected, though an engineer of unwieldy size has been known to put a lump of tallow on each of the bearings, knowing that it must melt before they get very hot. The peculiar penetrating smell of burning oil tells of such overheating, though usually too late to remedy it; and if the feed-water, which should be fresh, tastes salt, it tells of a leaky condenser and the amount of leakage, while every external part of the engines being under watchful eyes, all the senses are thus laid under contribution.

A careful study must be made of "knocks," so as to know what chiefly requires overhauling in port, for it is the pride of every engineer to run his engine as silently as possible. There is the dull blow of a "bottom end," and the lighter knock of a "top end," connecting rod brass, though it is sometimes impossible to detect the difference. The rattle of links, the noisy clatter of the saddle brasses on the valve gear, the peculiar click of a loose piston ring, or the sharp crack of water in a cylinder, must all become a well understood language to the engineer.

It is often difficult to localise a knock. It usually seems to come from anyplace to which the attention is directed, while the jar from it also is transmitted to every part. By standing in various places, so as to have the columns or other obstructions in the way, a deadening of the blow may sometimes be noticed, and then the engineer knows that the knock is behind the obstruction. In one steamer there was a slight but annoying jerk of the pump-links, accompanied by a mysterious knock, apparently at the rocking-shaft, on which there was an undeniable side jump. What caused it was the puzzle. The levers and beam centres were gauged and found in position, though the wear of the link brasses showed a twisting strain. This, after baffling at least two sets of engineers, was found to be due to a "built" crosshead between the circulating and air pump-rods being too short. The pump-rods were thus inclined towards each other, but so slightly that it could not be detected by measurement, as there is always a certain amount of play in the rods and buckets. A liner was at once put in where the two parts bolted together, and the rods being now parallel the noise ceased. In another steamer endless annoyance and exasperation was caused by a dismal groan from the engines, on the upstroke of the low-pressure piston, which could be heard all over the ship. It began just before the middle of the stroke, and finished about the top, making the engines quiver. Apparently it came from the low-pressure cylinder, and experiment showed that raising the low-pressure valve lessened, and sometimes stopped it, but to effect this the valve had to be raised abnormally high; abundance of oil in the cylinder also deadened it. During repeated overhaulings no marks of injury, or even of serious rubbing, could be seen on tail-rod, piston-rod, or cylinder. The low-pressure guide was lined up, the piston was run with tight springs and then with slack ones. The connecting rod was found to swing truly over its crank, and the top and bottom brasses had no conical nor side wear on them. The crank-shaft ran true, as shown by the steadiness of the main-bearing caps; the turning wheel was clear of its framing; the wear of the thrust had been taken up; the propeller shaft was sighted and found true; its couplings were slackened back, and showed by their parallel openings that there was no constraint on the shaft. The ship was then dry-docked in a foreign port, but the propeller was on so tightly that it could not be removed in the time allowed. The trial, however, proved it tight, whatever else was wrong. The noise still continued, till in a home port the vessel was again docked, and the propeller driven off, when its key was found completely "chawed up." This key had been driven hard home, binding on top and bottom, but allowing side play. Then, with the engines at work, on the upstroke of the low-pressure cylinder, when the heavy weight of its piston and rods was being lifted, with the high-pressure piston cushioning, and at its dead centre the revolving mass of the propeller acting as a fly-wheel tended to make it outrun its shaft, and the lessened circumferential strain then caused the shaft to spring back, jarring on its broken key. The sound was not only apparently but actually in the engine-room, and given forth by the hollow resonance of the low-pressure cylinder. This case is given in detail, for, though an extreme one, it is typical of many others.

When links knock, judicious experimenting with the snifting valve will tell if the circulating pump is overloaded; opening a drain cock will tell if a knock in the eye is due to water there, while an engineer just before going off watch has been known to open the injection wider, to see if his successor could discover the cause of the knock, which will in some cases be caused by the higher vacuum. Observation of the valve spindle gland will tell if the rattle of the link motion is due to the gland being too tightly screwed up or to the valve slot bottoming on the spindle, or to ordinary wear. The jumping of the main bearing caps will tell of a crank shaft wearing down out of line. The noisy clap of a main valve on its seat may be due to excessive cushioning sending up the compression higher than the steam pressure. This may be caused by the valve rod being lined up too high or let down too low, or it may be caused by too little clearance at the bottom of the cylinder. This is an important matter. All wear at cross-head, crank-pin, or bearings is downwards, and the pistons gradually get lower and lower in their cylinders unless lined up. If uncertain how much bottom clearance there is, the crank must be turned to the bottom centre and position of cross-head marked on guide. Then the connecting-rod must be uncoupled, and the piston let down to the bottom of its cylinder. This will give the bottom clearance, which it is well to mark on the guide for future reference, so as to save uncoupling again. Sometimes when the low-pressure piston is thus let down, it is difficult to raise its ponderous weight by block and tackle. The easiest way to get it up is to put back the connecting-rod in position. In place of its brass, removed put in a block of wood or sacking to prevent rubbing, and by turning the engines the piston will be pushed up into position, where it can readily be secured till the crank has been turned back and the brass put in. This, of course, is for work in port.

JACKSON'S PATENT HINGED BUFFER.



It is well known to those acquainted with the working of railways that one of the principal items in the repairs to rolling stock is due, either directly or indirectly, to the breakage of the buffer springs. The object of these springs being to deaden the shock and concussion due to the inertia of one portion of the train coming into contact with another portion, which may be either stationary or moving in an opposite direction, or in the same direction with a different velocity, it is, as might be expected, only too frequent that the buffer springs break under the shocks which they are intended to overcome; and with the ordinary buffers in general use, having closed cases, it is impossible to examine the interior of the buffer or to replace a broken spring without the trouble and expense of taking the buffer entirely off the buffer beam.

Again, it frequently happens that the buffer base plate is riveted to the buffer cylinder, in which case it becomes necessary to cut out the rivets in order to remove the base plate, and renew them again when the broken spring has been taken out and a fresh one substituted; so that, apart from the expense due to replacing the springs themselves, the loss consequent upon the whole wagon having to be laid up for the purpose of replacing the springs is very considerable, and of even greater moment than the mere cost of springs. These items combined tend to delay the replacing of broken springs, which often results in the buffer case being damaged by a broken spring, which would have been replaced had the conditions for replacing it been more favourable.

The buffer illustrated herewith has been designed to obviate these evils by providing a simple and efficient means by which the interior of a buffer may be examined, or a broken spring taken out and replaced by a new one without removing the buffer from the buffer beam.

As will be seen, the buffer cylinder is provided with a hinge, working into its counterparts, fixed either to the buffer base plate or to the buffer beam, and upon which the buffer case is free to move, so that in order to examine the interior of the buffer, or to replace a broken spring, it is only necessary to take off the two nuts on the opposite side of the buffer from that on which the hinge is placed, when the buffer case may be swung round on its hinge and the interior of the buffer exposed to view. These buffers are made either wholly or partially of wrought iron or cast steel, as required, Messrs. John Spencer and Sons, Newburn Steel Works, Newcastle-on-Tyne, being the sole licensees and manufacturers.

UTILISING THE NIAGARA FALLS.

A company was organised in 1886 for the purpose of utilising the power of the Niagara river by constructing a subterranean tunnel from the water level below the falls, about 200ft. under the high bank of the river, extending through the rock to the Upper Niagara river at a point about one mile above the falls, where a head of 120ft. is obtained. The tunnel is then to extend parallel with the shore of the river one and one-half miles at an average depth of 100ft. below the surface of the earth and at a distance of about 400ft. from the navigable water of the river, with which it is to be connected by means of conduits or lateral tunnels. Power is to be obtained from the conduits and not from the main tunnel itself. The conduit will, it is intended, lead to wells sunk to the tunnel 100ft. below the earth's surface. In these wells will be placed turbine wheels.

Sufficient capital has now been secured to proceed with the scheme. The prospectus states that since the incorporation of the company sufficient land along the river has been secured, surveyed, and apportioned into mill sites fronting on the river and on the line of the proposed tunnel, with ample streets and dockage, affording approach by rail or water to accommodate 238 mills of 500 h.p. each, or 119,000 h.p. in all, which is the estimate of the engineers of the capacity of the tunnel proposed to be built. It is a gigantic scheme, and if carried out as arranged the problems of utilising the mighty power of the Falls of Niagara will be practically solved.

HOT-AIR ENGINES.—III.

(*Continued from page* 63.)

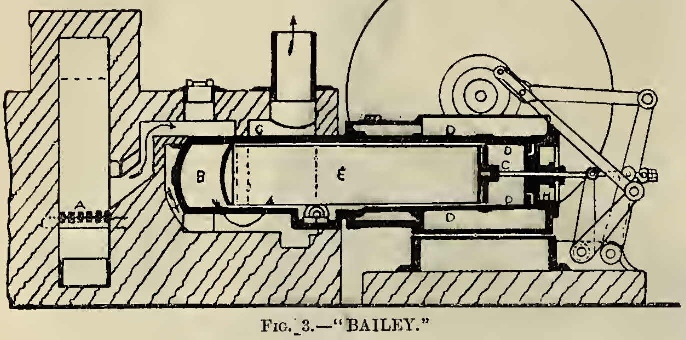


Fig. 3.—"BAILEY."

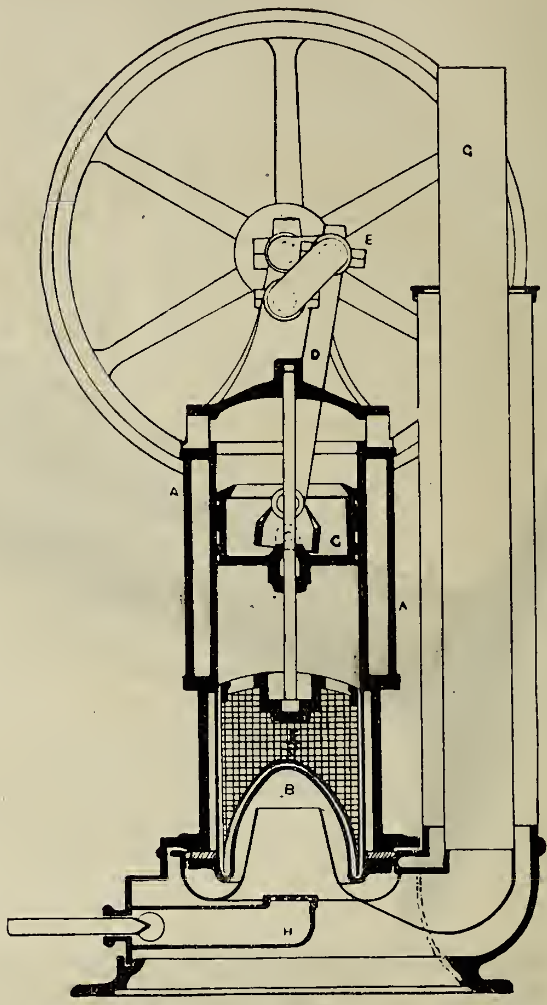


Fig. 4.—"ROBINSON."

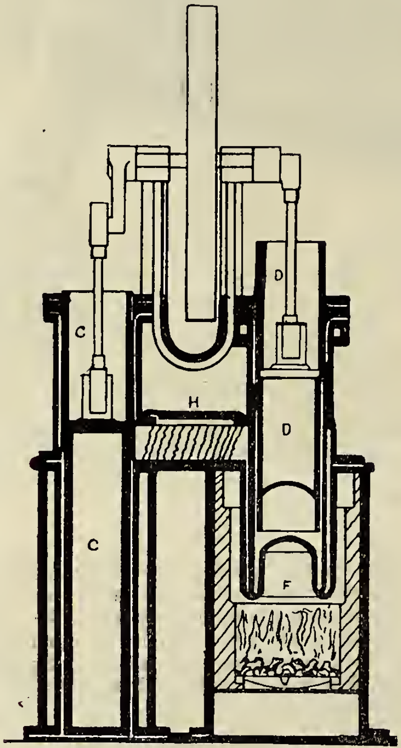


Fig. 2.—"RIDER."

The most successful hot-air engines of the present day are built on the principle of the Stirling hot-air engine, and all alike suffer from the same great failing as their prototype, in that the heater bottom or portion immediately over the furnace rapidly burns away. In the Stirling this failing ultimately led to the engine being thrown entirely out of use.

The only hot-air engines in the market now are the "Rider," "Bailey," and "Robinson," which are illustrated by figs. 2, 3, and 4 respectively, and differ only from Stirling's engine in the arrangement of the parts.

The "Rider" hot-air engine is manufactured by Messrs. Hayward, Tyler, and Co., and its arrangement will be readily gathered from fig. 2, wherein C and D represent two plungers working on a common crank shaft, but with a quarter of a revolution difference in position. D is the power plunger, and travels in a lined cylinder immediately over the furnace, F; C is the compression plunger, and travels in a water jacketed cylinder; H is the regenerator. The four operations performed in one revolution of the crank shaft are :—1. The air compressed under C passes through the regenerator, H, and receives heat therefrom, the pressure consequently rising. 2. The air passes into the cylinder under D, and, receiving heat from the furnace, does the work on D, and afterwards on C to a less amount. 3. The expanded air is displaced from D to C, losing heat to the regenerator, H, and also to the water jacket. 4. The displaced air is compressed under C, the power required for this coming from the flywheel. Each of these operations takes up a quarter of a revolution of the crank shaft—(1) beginning from the position shown at fig. 2. The useful power given out is the difference between that exerted at 2 and that absorbed at 4. This type of engine is made in three sizes, $\frac{1}{4}$, $\frac{1}{2}$, and 1 H.P., the revolutions being 100 to 150 per minute, with a maximum pressure of 20lb. to 22lb. The heaters last from four to five years, and have a dull red heat when working, or say 1,000° F. The consumption of coal per H.P. in the $\frac{1}{2}$ H.P. size is about 8lb.

The "Bailey" hot-air engine is made by Messrs. Bailey and Co., Salford, and is illustrated by fig. 3, in which E is the displacer, H the working piston travelling in a water jacketed cylinder, D, and A is the furnace. The regenerator consists of the metal in the sides of the cylinder and the long displacer. The piston, H, travels in the same way as in the ordinary engine, but the displacer, E, has alternate quick and slow motions, to give more time for the heating and cooling of the air. Fig. 5 is a copy of an indicator diagram from 1 H.P. engine, giving 2·37 H.P. with 14·7lb. as the highest pressure. The relative brake H.P. was 1·31, or a mechanical efficiency of ·55; the estimated consumption of coal was 10lb. per H.P., and the quantity of cooling water 30 gallons. The estimated temperature at atmospheric pressure was about 700° F., and at the highest pressure 1,500° F.

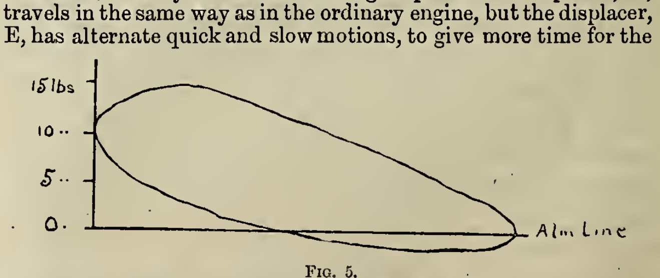
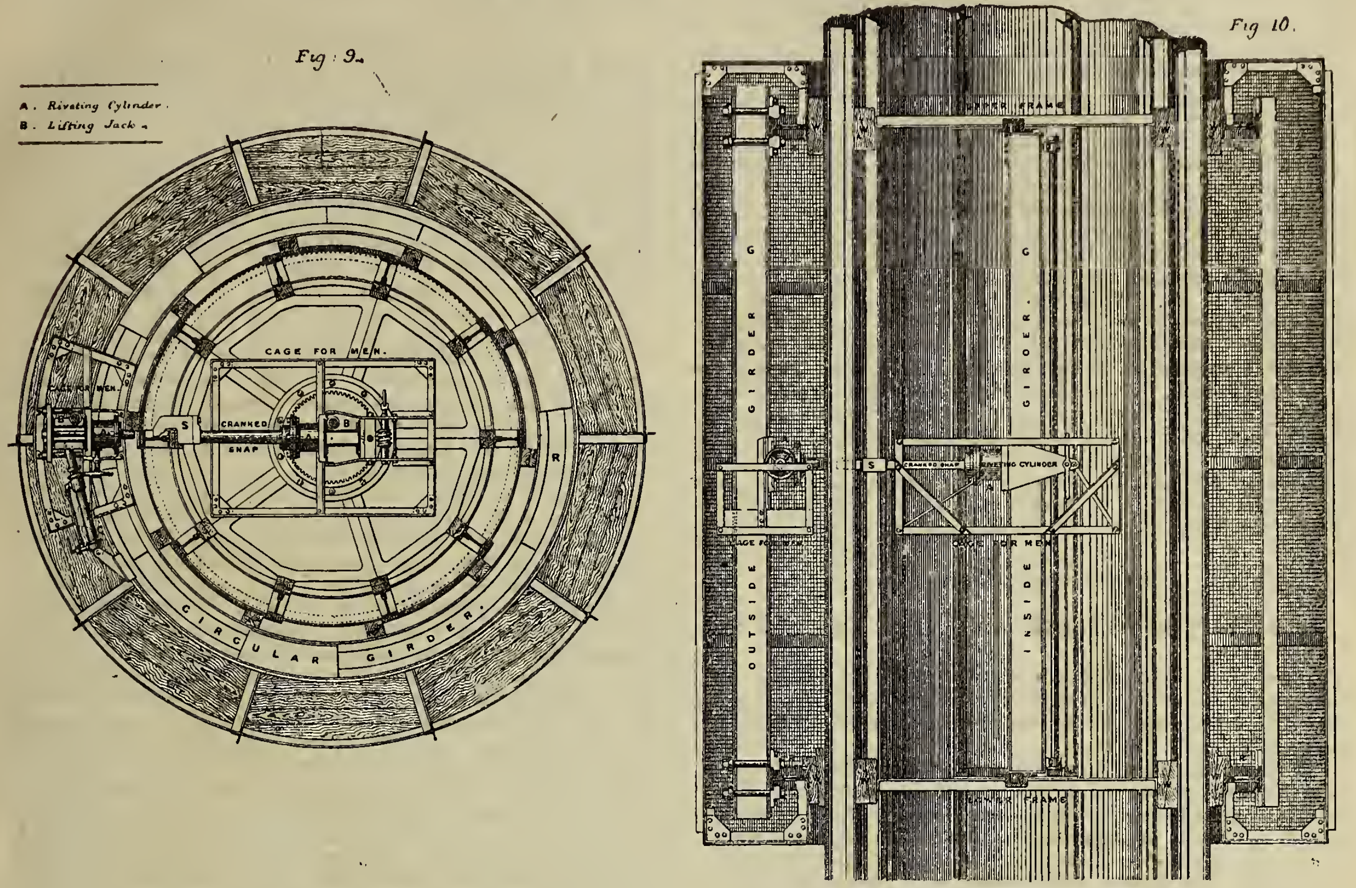


Fig. 5.

The "Robinson" engine is now made by Messrs. F. Pearn and Co., Gorton, and is shown in section at fig. 4, where H is a bunsen burner, F the displacer, with a regenerator of wire gauze,

HYDRAULIC APPLIANCES AT THE FORTH BRIDGE WORKS.—IV.

By Ernest William Moir, Stud. Inst. C.E.



SECTIONAL PLAN. VERTICAL SECTION

VERTICAL COLUMN RIVETER.

and G the working piston travelling in a water jacketed cylinder, A. The piston and displacer are driven from separate cranks close together, but with one in advance of the other. During the working of the engine the displacer, F, is moved from below upward, so as to drive the air from under G, through F, where it receives heat from the regenerator, and passes under F, and is still further heated by the burner, thus rising in temperature and volume, and driving the piston, G. The displacer, F, now returns to the lower end of the cylinder, driving the air through the regenerator, where it loses heat, and is still further cooled by the water jacket, consequently contracting and allowing G to make the return stroke. Unfortunately no complete public tests appear to have been made with this engine.

HYDRAULIC APPLIANCES AT THE FORTH BRIDGE WORKS.—IV.

(Concluded from page 211.)

Fig. 10 is a vertical section of one of the 12ft. tubes, showing this machine in place, fig. 9 being a sectional plan. R and R' are two heavy steel girders, 22ft. apart, kept at their correct distance by angle-iron framing, which when covered with small mesh netting makes a complete cage, from which nothing can fall. The rings are kept at a uniform distance from the skin of the tube by hard wood wedges driven in opposite the stiffening, H, beams. G is the vertical riveting girder, held by cast-steel clips to the outer flange of the circular rings, but it can be moved to any position in their circumference by the small hydraulic jacks, C (fig. 9). On the face of the girder, held in a cast-steel sliding saddle, is the riveting cylinder, to which there is also attached a small platform for holding the men, whose business it is to attend to the closing of the points of the rivets. The saddle, with its stage and cylinder, can be raised or lowered to any position by the small hydraulic jack, B, the cock controlling which is within easy reach of the men on the stage.

Holes are provided in the faces of the girders as well as round the circumferences of the rings, against pins passed through which the rams are made to bear, either to raise the cylinder or to alter the radial position of the girder. There is then on the outside of the tube a vertical girder, movable to any position round the circumference, carrying a cylinder which is capable of putting a pressure of 40 tons on the point of a rivet on any part of a length of 17ft. The inside girder does not travel bodily, but is made to rotate by suitable gearing, within easy reach of the men on the small lifting platform, upon trunnions at its ends (plate 9, fig. 10). These trunnions are held in a central position by angle-frames at the upper and lower ends of the girder, which are wedged to the faces of the longitudinal stiffening beams of the tube, and rest upon small movable brackets.

The cylinder is in this case far from its work, but is provided with a long snap, having a movable cranked end, so made to get in at the backs of the angles on the, H, beams (fig. 9). The cylinder, platform, and men are raised and lowered by a small hydraulic jack, in the same way as on the outer riveting girder. There is then inside a cylinder of the same power as that without, which can be brought to bear on the head of any rivet in a length of 17ft. of the tube. The whole machine is suspended to the platform above, and is raised with it in 16ft. stages, or sufficient to put on one course of plates.

The water is admitted to both cylinders at once from one cock, but is delayed by a suitable valve from entering the outer cylinder until the rivet is well pushed into the hole from within.

The rivets are heated in a specially designed oil furnace, just above the machine, inside the tube, and have been put in at the rate of eight hundred per day of ten hours. The machines used in the diagonal tubes are similar as far as the outer rings are concerned, except that instead of being circular they follow the outline of the flattened tubes upon which they work. The longitudinal girder is made to traverse a path at a uniform distance from the inner sides of the plates, upon raised ridges, which are attached to the upper and the lower diaphragms, forming the inner framing of the machine.

The last subject to be dealt with is the raising by hydraulic jacks of the approach viaducts, the larger of which is 1,680ft. long, and weighs about 2,000 tons. The viaducts are in 168ft. spans, continuous over every second pier, and so closely connected at the non-continuous pier that it was decided to lift all the girders at one time. Two inverted 15in. jacks were employed on each pier; these were fixed into a temporary cross-girder, bolted to the under side of the viaduct. Four stacks of hard wood blocks were placed beneath the cross-girder, which, during the time the lifting operations were going on, were kept closely packed by means of long slip wedges. There was also placed under each cylinder a pile of blocks, against which the rams pressed while the girders were being raised. On the completion of a lift, which was always enough to allow of the building of three courses of the pier, the stacks were removed one by one, to enable the masonry to be set beneath them, being again replaced after the new work has been allowed sufficient time to set. When the three courses of the pier were finished, forty-eight hours were allowed for the proper setting of the cement, before another lift was taken. The high-pressure water was supplied at 34 cwt. per sq. in., by steam pumps, the engines of which, during the building operations, were used to work by rope gearing the friction-hoists for setting the masonry. The rate of building and lifting, including the time allowed for the setting of the cement, was about 10ft. per month, and a lift of between 4ft. and 5ft. occupied about two hours. The north and south viaducts have been raised, by the means here outlined, over 100ft. without any mishap, and are now at their final level.

THE MANUFACTURE AND USE OF STEEL.

The annual meeting of the Iron and Steel Institute was commenced on Wednesday week, at the Hall of the Institution of Civil Engineers, Westminster; the president, Mr. Daniel Adamson, being in the chair.

Sir Henry Bessemer, in presenting the Bessemer gold medal, said: Perhaps without in any way making an invidious comparison he might say that the unanimous decision of the Council to award the medal to their president met with his most cordial and entire approval. If they went back some thirty years from the present time, he remembered, even in the stronghold of steel making, in Sheffield, not one man could he find who sympathised with his process, or gave the smallest belief to his success. But, fortunately for him—fortunately, he might add, for the world—there was outside of Sheffield a man who could appreciate it—a man at least who was determined to investigate it, to look into it on its own merits, to test it in every way that a practical man could test a new material. That man was his friend, Mr. Daniel Adamson.

The President, in accepting the medal, thanked Sir Henry Bessemer for the kind words in which the presentation had been made. Referring to his connection with Bessemer steel at a time when it had no friendly support, he said that he had been induced to try Bessemer steel because some puddled steel made by the Mersey Forge Company, in 1877, was found not quite satisfactory. He then examined the materials produced at Sir Henry Bessemer's experimental works at Sheffield, and came to the conclusion that if they could make good material, only exceptional now and then, it could not be the fault of the operation, but it must be the fault of not making a wise selection in that material which would always lead up to the same results. He had followed this up by seeing the material rolled at Rotherham, and having some experience in the cross-examination of workmen, he had the privilege to cross-examine the rollers at Messrs. Brown's, at Rotherham, on the material they were then working. There was but one conclusion amongst the men, that they had never rolled such material before, and to them it was a surprise, because it turned out a sheet with a round, pleasant edge, instead of a serrated, rough-sawn formation that had been common to all steel they had rolled previously. They must feel that it had been a great success when he had a record of 3,000 boilers working which were made largely of Bessemer steel in the shells, and in former times altogether of Bessemer steel. The Council had kindly considered that this gold medal should be presented to him for his past services, but he was sure it would not have been presented to him if it had not been that he had had such excellent support from gentlemen like the late Mr. John Platt, of Oldham, and his esteemed friend, Mr. William Richardson, of the same firm. (Applause.) He not only encouraged him in its use, but pressed upon him the necessity of a more scientific and moderate treatment than what was adopted in the use of a boiler plate before that time. From that encouragement a good deal of its subsequent use had sprung, and he was sure that Messrs. Platt had never had reason to regret it, for he had himself supplied them with over 100 steel boilers for their works, their collieries, and their locomotives.

PRESIDENT'S ADDRESS.

The President, who was received with applause, then said: This being the 40th meeting that has been held since the formation of the Iron and Steel institute, in 1869, it will be satisfactory to make known that the institute continues to advance in usefulness, and to increase as regards the number of members. The necessity of this Institute will be seen when we bear in mind that the production of pig iron in the United Kingdom, in the United States of America, in Germany, and the leading States of Europe (which may be considered as the world's output), amounted in 1887 to 21,832,663 tons, as compared with 19,818,100 tons in the previous year, showing an increase of over 2,000,000 tons of pig on 1886. The total production of Bessemer steel rails in Great Britain last year amounted to 1,021,847 tons, leaving 1,039,153 tons of Bessemer steel for other purposes, minus the scrap and loss in manufacture. The most important use of steel, outside of railway bars and tires, is its application to steamships of the mercantile marine; and I am indebted to Mr. Parker, chief engineer to Lloyd's Registry of British and Foreign Shipping, for a communication, in which he says: "I am unable to furnish you with a table showing the annual increase in the use of steel for boilers, but I can safely say that for the last four years we have scarcely had an iron boiler submitted for our approval, whereas during each of these years there have been built, under the inspection of the surveyors to this Society, some 600 steel boilers, representing about 24,000 tons of material. Thus the introduction of steel for marine boilers has admitted of pressures being increased almost 100 per cent, and this in its turn has caused marine engineers to construct an engine that can economically utilise these pressures, commonly called triple expansion engine, which I fully give you credit for introducing for land purposes some years before—viz., 1862. These improvements and advances in the machinery of steamships have reduced the consumption of coal quite 25 per cent, as compared to what it was ten years ago, so that it can safely be said that by the introduction of steel during the five or six years following 1878, superior ships have been built capable of carrying 4 per cent more cargo on a consumption of 25 per cent less coal, and this is quite sufficient to make a vessel a paying piece of property, while rendering vessels previously built obsolete." In 1879 no steel appears to have been used. But now we come to a period—1880—when steel seems to have been used in earnest, as a consumption is recorded of 21,895 tons for steamers, and in this same year is seen the first application of steel to sailing ships, the quantity used being 1,002 tons. The present employment of steel in the construction of steamers must certainly be considered remarkable, as the percentage used in 1878 as against iron was only 1·09; while in 1887 the percentage of iron used in proportion to steel was only 10·93. My own works might be taken as illustrating what has been done in the application of steel in the manufacture of stationary engine boilers. In 1878, at which time my firm had made over 1,400 steel boilers, the proportion of iron used was 34·2 per cent, as against steel 65·8 per cent. Five years later, or 1882, the consumption of iron had diminished to 15 per cent of the total material, while steel had risen to 85 per cent. Probably the next largest example of the growing use of steel is that of the construction of bridges, the most notable being that of the Forth Bridge, now being erected from designs and under the superintendence of Sir John Fowler and Mr. Benjamin Baker. Nevertheless steel has not as yet met all the requirements of manufacturing engineers. If steel is to supplant wrought iron for case-hardening purposes, it will have to be by the adoption of some special compound that is not understood at this time, or, at any rate, is not yet before the public; and it is for those who are directly interested in the matter to consider whether it is worth their attention to produce a steel more in accordance with the composition of high-class Yorkshire iron, so that it might be case-hardened with the same certainty, and yield as good results in its practical application as that metal. Then some further small advantage would be developed by the use of steel, as it would be clear from cinder, and not liable to crack or split when being hardened. The conclusion I have myself arrived at is that it will require a steel with a much larger proportion of silicon than we have been in the habit of using for such purposes; but more information is desirable before presuming that such a compound would meet the requirements of the practical engineer. The ironfounder must now closely observe the quantity and character of the common alloys contained in the pig iron he uses, as the best combination of foreign elements in cast iron is the most important consideration to the user and the buyer. It is of little importance where or in what district pig iron is made, its value depending upon what it contains as an admixture. The same question of selection and adoption applies with equal effect in cast iron, as in the wise selection of special compound alloys to constitute mild ductile, medium strong, or even hard and very strong steels. I attach the greatest importance to this more technical examination and application of cast iron for every practical purpose, as, outside of high-class hematites that are used for the manufacture of Bessemer and open-hearth steel, selections may be made giving the highest results without using some of the higher-priced irons that are now considered necessary for given purposes. Should the consideration of the subject lead up to the ironfounder and forge master being better able to compete with the ever-advancing competition of the world, I shall be abundantly compensated for any trouble I have taken in calling your attention to this subject.

CONTINUOUS MOULDING MACHINERY.

At the meeting of the Iron and Steel Institute, on Thursday week, Mr. James Johnson (Manchester) read a paper on continuous moulding machinery at the works of M. Godin, at Guise. At these works (where the workmen participate under certain conditions in the profits) the moulding machinery consists of four circular platforms, on which are fixed the boxes containing the patterns to be reproduced. These platforms are turned round by gearing, and are stopped at each point where one of the moulding operations has to be performed. After the distribution of the sand for forming the mould, the next step is the pressing of the mould by means of a hydraulic press, making not only a better mould but saving the heaviest part of the moulder's work. As soon as the operations have been completed on the first revolving table, the moulding boxes are transferred to a second revolving table, on which the mouldings are finished by the workmen, who do their work without moving from their respective positions. The moulds are then transferred to another revolving table, the two parts being put together and closed ready for casting. This third revolving table carries the mould quite close to the cupola, and enables the moulder to use perfectly hot metal, and saves the labour of transporting the metal over the whole area of the foundry. The cast moulds are then transferred to another revolving table, on which the sand and castings are cleared out of the moulding boxes, the castings being sent on to the dressing-house, and the sand being treated by special appliances to prepare it for use again. The whole of the heavy work of moulding is done by machinery, the workmen's functions consisting in directing the operations, the result being a production of a much superior character and a saving in the cost of production of one-third. The number of men employed in connection with the moulding machinery is 43, while formerly 300 men were required to perform the same amout of work by hand.

HER MAJESTY'S SHIP MAGICIENNE.

The first of the five twin-screw swift cruisers ordered by Lord George Hamilton last year, was launched on Saturday from the yard of the Fairfield Shipbuilding and Engineering Company at Govan. She may be regarded as an entirely new type of vessel in the British Navy, for she has absolutely no armour on her sides and depends for her powers as a fighting vessel wholly upon the position of her vital parts, her speed, and the ease with which her guns can be manipulated. Her engines and boilers lie low and occupy nearly the entire length of the ship; they are encased in a double bottom and double sides, and are covered by a steel protective deck, that springs from the sides four feet below the water line, rises at an angle of 25deg. on either side and lies level in the middle for a breadth of 20 feet. The dimensions of the ship are 265 feet long and 42 the extreme breadth with a depth of 23 feet. She has a freeboard of 12 feet. Her displacement, when fully equipped and loaded with coals and stores, is estimated to be 2,950 tons. The hull is built of Siemens-Martin ⅜in. steel, covered with two thicknesses of teak, making 6in.; and this again is to be covered with copper to fit the vessel for service in distant waters. The stem, formed as a ram, is cast of phosphor-bronze, and is sustained in the rear by the protective deck and frame of the vessel. The stern-post and rudder-frame are also phospor-bronze castings, and the rudder is balanced on pivots. The vessel is designed to go 20 knots, with a steam pressure of 155lb., generated in four double-ended boilers, each with six corrugated flues, and with a forced draught supplied by eight double-sided fans. Two of these boilers occupy one of the four engine-room compartments, and each engine has a compartment to itself, completely cut off from its neighbour, and working its propeller independently of the other. The propellers are three-bladed, cast of phosphor-bronze, and placed well forward of the rudder. The engines, which are being made at Newcastle by Messrs. Hawthorn, Leslie, and Co., are triple expansion, with a 3ft. stroke working horizontally from the side. The cylinders are 34½in., 51in., and 76½in. in diameter respectively. The engines are largely made of steel so as to insure lightness, and the horse power expected is 9,000.

The engines and boilers occupy the major portion of the space below, but the designers have contrived to accommodate beneath the steel deck the whole of the steering gear; and the magazines are also placed below, and in the middle line of the ship, partly before and partly in the rear of the engines and boilers. The submarine mining stores and provisions are placed on the platform which forms the crown of the magazine forward, and the ship is worked, both for navigation and fighting, from the conning towers on the poop and forecastle.

The armament consists of six 6in. five-ton guns with Vavasseur central pivot mounted carriage. There are also nine Hotchkiss quick-firing six-pounders that can be worked with the same ease as a revolver, one three-pounder, and numerous Nordenfelt machine guns. She has also six torpedo tubes, four on her broadside and a fixed tube fore and aft. The ship is lighted by electricity, and she has three powerful electric search lights, one on the forward conning tower and two aft on the upper deck. She is amply provided with pumping and flooding machinery.

BULL'S METAL.

We have this week, says *Industries*, seen samples and test pieces made from a new alloy, containing copper, zinc, and some other metals, which at present are the secret of the inventor, Mr. Jno. Bull. The metal is at present prepared in two varieties. One is a soft variety, which is more adapted for cold working, and which has a tensile resistance of slightly over 30 tons; the other is a strong variety, with a tensile resistance of nearly 35 tons; but this alloy is not so well adapted for cold working. Both varieties can, however, be forged and stamped at a dull red heat, the same as wrought iron. In the diagrams, which have been prepared from tests made by Messrs. J. Buckton and Co., of Leeds, and which we have had an opportunity of inspecting, the strong metal exhibits a very peculiar property. Shortly after the elastic limit has been passed, which happens with a load of 24 tons, there is a sudden drop in the curve; but on further straining the metal it seems to recover itself, and there is as sudden a rise, so that finally the curve passes on as if this period of unstable equilibrium had not existed. Certain qualities of mild steel exhibit a similar property; but we have never seen it so marked as in this metal. At the tests referred to, the hot rolled sample bar of the strong metal broke at 34·76 tons, with an elongation of 19·3 per cent., whilst the soft metal showed 30·46 tons tensile resistance, with an elongation of 30 per cent. We have seen test pieces of Bull's metal made from a round bar at a dark-red heat, which in finish leave nothing to be desired. The inventor states that the metal can be cast like gun metal, in dry moulds. The chief precautions to be observed are to use a large head, stir up and skim well, and pour quickly.

ACTION OF WATER ON GALVANISED IRON PIPE.*

BY W. R. NICHOLS AND J. K. RUSSELL.

In this paper, which was read before the Boston Society of Civil Engineers, are given the results of experiments made to show the quantity of zinc actually taken up by Boston water in galvanised service pipes, under ordinary conditions. Though it is usually possible to detect zinc in water which has passed through any considerable length of zinc-coated pipe, yet it is believed that the proportional quantity either in suspension, as a hydrocarbonate, or in solution, was too inconsiderable to be objectionable from a sanitary point of view.

The experiments were made with a length of 39ft. of ½in. galvanised pipe, connected with the water service of the building, in such a manner that the water in the pipe could at any time be displaced by fresh water, without allowing air to enter. Zinc was found, in solution and in suspension, wherever water had stood in the pipe for from seven to seventy hours. Water that had remained in the pipe for several days did not contain a greater proportion of zinc in solution than for shorter periods, but the quantity of zinc in suspension was augmented. The water held in solution 0·3 to 0·6 parts of zinc per 100,000 parts of water, and in suspension from 1·5 to 2 parts per 100,000 parts of water; or, 0·3 grain per gallon in solution, and 1·0 grain per gallon in suspension. In water in regular flow, no zinc was discovered; but when the rate of flow was reduced to 1 quart per hour, 0.9 part per 100,000 was found in solution and suspension.

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* Foreign Abstracts Civil Engineers.

It is inferred from these observations that the zinc coating is slowly but continuously dissolved. In order to determine the thickness of the coating and the depth to which it penetrates the iron, some rods of wrought-iron, 6in. long, were turned off for a length of 4in., to a diameter of 0·901in., and coated in the usual manner to a diameter of 0·905in., showing an increase of $\frac{4}{1000}$in. in diameter, or a ring $\frac{2}{1000}$in. thick. Three rods thus treated were reduced in the lathe to their original diameter, and the turnings consisted of zinc and iron in the following proportions:—

	Zinc.	Iron.
No. 1	97·08 per cent	2·19 per cent.
No. 2	96·42 „	1·87 „
No. 3	97·20 „	1·70 „

On still further turning down the rods, below the normal diameter, zinc was discovered in sensible proportions, showing that it does slightly penetrate the iron, forming an alloy.

The insoluble precipitate formed by the action of water on zinc was found, when analyzed, to consist of zinc, water, and carbonic acid, forming a zinc hydrocarbonate.

Tests were also made of a pipe coated with a composition of lead, tin, and antimony; and of a brass pipe. Lead and tin in the former, and zinc and copper in the latter, were found in solution.

CORRESPONDENCE.

We do not hold ourselves responsible for the opinions of our Correspondents.

PROPOSED ENGINEERING ASSOCIATION.

To the Editor of "The Practical Engineer."

Sir,—Allow me a little space in your excellent journal on the above. A preliminary meeting was held on Wednesday evening, April 18, at 737, Hyde Road, Gorton, to promote an engineering association, with the object of discussing subjects of interest to engineers and others engaged in mechanical pursuits, and to provide opportunities of reading papers and lectures on technical subjects of local and general interest. It is proposed that it be called the General Engineering Association, and shall consist of those whose character and abilities will bear the strictest investigation. The first lecture took place on May 2, when the President (Mr. Alfred Bullivant) took the chair. Mr. Burcham, of Openshaw, gave a lecture on the advantages of the compound engine, illustrated with diagrams.—Yours, &c.,

J. Booth, Corresponding Sec.
May 14th, 1888. H. Jackson, Financial Sec.

THE FRIEDENSHUTTE BOILER EXPLOSION.

To the Editor of "The Practical Engineer."

Sir,—Your notice of the report of the above explosion has done much to strengthen an opinion held by myself for many years, that many explosions (especially of economisers) that are now booked to overpressure are due to no other cause than gas explosion. In the case in question there can be no doubt whatever as to the cause. The men would no doubt be giving more time and thought to themselves than the boilers, and consequently the fires on the grates may have been allowed to get low—in fact, too low to ignite the gas which may momentarily have ceased to flow; consequently the flues would become full of an explosive mixture which would explode with sufficient force to disturb the balance of the steam pressure versus boiler shell; hence the explosion. To anyone with an extended experience where blast furnace gases are used these explosions are no new features, but fortunately they are seldom so violent as to unseat a boiler, as the ends of flues often fail and relieve the pressure. In a number of boilers, with which I had some experience, explosions were very frequent, particularly when ore, coke, and limestone were put into the furnace wet. In this case each flue was fitted with a large flap valve on an angle, its own weight resting against the seat being sufficient to keep it draught-tight. Some of the boilers had fire grates, others had none. But iron rods were continually kept white hot to ignite the gases in the boilers without fire grates, and I assure you there used to be some skipping about when lighting these gasses, for many a time the brickwork, valve and all, would be blown clean away at the back end of boiler, while in one case a boiler full of water was lifted eight inches, breaking the steam pipe. It is not the gas that does the damage, it only destroys the boiler or economiser, and then the escaping steam and water completes the destruction. I have seen one case where there was no steam pressure at all, and the destruction was complete, this from coal gas, and another another case where the economiser was completely destroyed in July, when we don't usually have frost, and there was neither wear, tear, or stoppage of pipes visible. In my opinion gas is responsible for more than it is credited with.—Yours, &c.,

Chalkline.

May 14th, 1888.

THE STEAM ENGINES AND BOILERS BILL.

To the Editor of "The Practical Engineer."

Sir,—With your permission I will say a few words in reply to "J. S. S." Would "J. S. S." or any other sensible man still blame the man in charge after he had reported any defect to his superior or owner, or the one who handles the *£ s. d.*? "J. S. S." can have $\frac{7}{16}$ or $\frac{5}{8}$ iron or steel plate if it suits him, as what I wished to express was that an inspector can see no more in a boiler than an experienced attendant, if it were made his duty to know a defect when he saw one—besides handling the shovel. With regard to the so-called sneering remark, all I can say is that the boiler was thoroughly prepared by a man who knows how to prepare a boiler for an entire examination. I still think it would be a great benefit to all concerned if men in charge of boilers were compelled to pass a practical examination. I happened to go into a boiler-house the other day, and saw a piece of cast-iron pipe hung on the safety valve lever. I asked the attendant in charge what was the matter, pointing to the weight; he said, "I have got to do that to keep going till dinner time." Did his master know of it, or did he know the danger of such a practice? Another instance I may give, where the water from the roof of the boiler-house runs down and lodges on the brickwork of the side flue on a rainy day so excessively that you could float a small boat on it. How long this has been going on I don't know, but the firm changed its man, and the master was informed of the damage caused by such gross neglect and ignorance, and he at once took steps to insure the boiler. How many inspecting or insurance companies would refuse the responsibility, whether there were proper facilities for examination or not? I fear the only one that refuses an inaccessible boiler is the one in Mount Street, Manchester, and that is the reason why they are the smallest in point of numbers, though the oldest inspecting company. I think "J. S. S." must acknowledge that the majority of the attendants in charge of small boilers are themselves too ignorant of the dangers to inform anyone else of the same.—Yours, &c.,

Ignorance.

May 14th, 1888.

THERMO-DYNAMIC ANALYSIS OF THE GAS ENGINE.

To the Editor of "The Practical Engineer."

Sir,—In reply to your correspondent, Mr. W. A. Carlile, I may state that I am quite willing to clear any point of obscurity that may have appeared in my paper under the above title, and to dispassionately discuss any points which you, sir, may think of sufficient general interest to your readers; but I do not think it advisable or feel disposed to bring in matters pertaining to my personal and private business arrangements. Your correspondent's remarks are wild in the extreme, and some glaringly inaccurate. In the first place, he has no authority for stating that my patent is apparently abandoned, and I can assure him that I have no intention of abandoning it in the face of a real marketable value. An apology for such an inaccuracy on his part would at least be gentlemanly. Turning to matters strictly under the title of my paper, Mr. Carlile himself advances, in his first paragraph, the very element of contradiction to his own deductions in reference to agitation after ignition; for is not the fact of the very short time there is available for the whole effective operation of combustion the very best argument which could be produced for the most violent and constant agitation which can possibly be produced? His very first phrase is acknowledging that my diagram "simply emphasises the fact that the atoms which seek to combine cannot get at each other," and yet only a few lines further on he says: "Besides, with the gases completely mixed previous to ignition, a movement almost inconceivably small would bring the required atoms into contact, supposing agitation to be the chief requirement." This is so inconsistent that I think it answers itself. Further on, passing his personal queries, he makes the remark that "nothing less than a white-hot cylinder will light the mixture." I would recommend him to get a red-hot poker, and hold it over a common gas jet, and keep turning the gas on and off as the poker cools. By this simple experiment he will find that ignition will take place when the poker has almost turned black, or about 700 or 800° Fahr., and this at atmospheric pressure. If he will try the experiment under several atmospheres of pressure, he will find the temperature of ignition very much lower even than this. A white heat is about 2,500° Fahr.

The air I purpose using for my cool injection will be about the temperature of high-pressure steam, and straight from the pump. The advantage of the injection is that it will waste no heat, but in passing along the narrow hot annular space between the cylinder lining and piston plunger it will expand in absorbing their heat and do an equivalent of work, instead of absorbing it to waste, as is the case with the water jacket; thus my engine is a regenerative engine without the cumbersome regenerator usually applied.

If you think fit to give any particulars of the trials of my engine, I hope shortly to be able to supply them, and will acquaint you in due course.—I am, sir, yours faithfully, HERBERT GUTHRIE.

Albert Road, Levenshulme, 14th May, 1888.

[We shall be pleased to find room for the particulars of the trials of Mr. Guthrie's engine as soon as they are ready.—ED. *P.E.*]

QUERIES AND REPLIES.

COMPOUNDING.—We have a pair of high-pressure engines which we want to make compound by changing one cylinder. Will some reader say what amount of condensing water per minute will be required, and the size of pond; also what is the best automatic cut off for D valves? The cylinders are 14in. diameter by 24in. stroke, and make 83 revolutions per minute; cut off at 10in. Boiler pressure 60lb., but not more than 50lb. on the piston. Port opening $6\frac{3}{4}$ by $\frac{5}{8}$.—J. A.

Answer.—In reply to "J. A.," the quantity of condensing water required by his engine, when altered as he suggests, is, amongst other things, dependent on the amount of work he then requires it to perform as also on the amount of expansion which he proposes to adopt, as to which matters he gives no information. I presume the boiler pressure of 60lb. which he names is that shown by the gauge, thus making the absolute pressure about 75lb. If, in compounding, full advantage be taken of this pressure by continuing the expansion to its extreme useful limit, and still cutting off the steam in the 14in. high-pressure cylinder as at present at $\frac{10}{24}$ of the stroke, and exhausting into the low-pressure one of about $25\frac{1}{2}$in. diameter, and there steaming through the stroke, and from thence passing the steam to the condenser, I should think that about half the quantity of steam now used will do the work. The engine will develop about 110 h.p., and under that load will require about 88 or 90 gallons of condensing water per minute; and a cooling pond about 110ft. square, or of surface area about 12,000 square feet. There is no efficient or recommendable automatic cut-off for D valves.—W. A.

SETTING LOCOMOTIVE SLIDE VALVES.—Would any reader inform me of the usual method of setting locomotive slide valves?—IONORAMUS.

Answer.—In the case of a locomotive with outside cylinders, lying horizontally, the valve setting is as follows: Before the wheels are fixed on the axle, the eccentric-sheaves are put on loosely. The key-seats having already been formed in them, it remains to form the key-seat in the axle after the wheels are fixed. This is done as follows: The wheels and axle are placed in a position where they can be turned easily. A circle the same diameter as the crank-pin is described on the end of the axle, and a straightedge applied to the circumference of this circle and the crank-pin, and levelled by a spirit-level, the opposite crank hanging downwards.

The eccentric-sheaves for the "opposite" crank are then turned with their throw-centres upward, and levelled by placing the spirit-level across them. The key-seat is then marked off, and the same operation carried out for the other set. The sheaves being fixed, and the whole of the gear in position, the valve is set as follows: The crank-pin and circle are again levelled, and the valve of the corresponding cylinder is put in the position for giving the "lead," the link being in full gear. The arrangement of nuts, &c., is then slightly tightened up, and the crank-pin turned to the opposite centre and again levelled. If the gear is of the proper size, the "lead" will be given for the opposite end without the necessity of shifting the nuts, &c., which can then be tightened up. These nuts, &c., give the opportunity of distributing any slight inequalities equally between both ends. The sector for the reversing lever is graduated for the different grades of expansion in the same manner, by noting the points of cut-off for opposite ends and marking these positions on the bracket.—DREADNOUGHT.

SENSITISED PAPER.—Would some reader kindly give me the names of the chemicals and proportions of the solution for coating paper for taking copies of tracings by the same method as printing photos from a negative?—SURFACE TABLE.

Answer.—Sensitising solution: *A* Citrate of iron and ammonia, 100 grs.; water, 1oz. *B* Red prussiate of potash, 70 grs.; water, 1oz. These will keep as long as desired when separate, but when mixed (equal quantities) for use should be used in the dark room, and any that may be left must be kept there. Apply lightly with a full sponge.—DREADNOUGHT.

Answer.—If "Surface Table" will refer to No. 10 of *The Practical Engineer*, he will find a somewhat lengthy article on the subject. The formula for the sensitising solution is as follows: Ammonia citrate of iron, $9\frac{3}{8}$ ounces; Ferricyanide of Potassium (red prussiate of potash), $6\frac{1}{4}$ ounces; to be of pharmacopœia quality. Each of the above quantities to be dissolved separately in one pint of distilled water, and then mixed. If the querist does not need such a large quantity at a time, of course he may reduce each of the above ingredients to suit his requirements. The above solution will give a copy having white lines on a blue ground, but if "Surface Table" would like to experiment with the more modern style, viz., black lines on light ground, I can supply him with the particulars of the solutions necessary for the purpose.—OMICRON.

Answer.—In answer to "Surface Table," I think he will find the "blue" process the simplest. Solution, ammonia citrate of iron, 2oz., in 8oz. of water; second solution, red prussiate of potass, 2oz., in 8oz. of water. Keep in darkened bottles, and mix when wanted; sensitise plain paper, and hang up to dry in a dark room. When printed, wash well with water, then dry. Any alkali will write on the blue ground.—A. FINDLAY.

HOT GASES.—Would "W. A." or some other reader be good enough to inform me as to the best means of drawing a portion of the hot gases away from the base of a chimney or shaft, through a series of vessels, and discharging the said gases at a temperature of about 260° Fahr. into the atmosphere? I would also like to be informed as to how I could manage to separate the soot, &c., from the gases before entering the vessels, so that there might be as little sooty deposit as possible.—X. B. I.

Answer.—In answer to "X. B. I." as to drawing hot gases from a chimney, I would suggest, if admissible, the use of an exhausting and forcing fan, which, after drawing the gases from the chimney, passes them through a perforated emission pipe, which is immersed in a shallow vessel of water. On the gases passing through the water they would be cleansed of much of the soot, tar, and ammoniacal liquor they contain. The temperature at which the gases escape from the water would depend on the respective temperatures of the incoming gases and water, and the speed at which the gases are passed through.—W. A.

WINDING ENGINE.—Will some reader kindly assist me by working out the following: What will be the dimensions of an engine, with two cylinders, capable of raising 400 tons of coal per day of nine hours, from a drift 600yd. long, dipping 1in. per yard, working eight trams each journey, weight of each tram 9cwt., and coal in each tram 35cwt., making a total weight of tram and coal = 44cwt.; pressure of steam 40lb. per square inch; size of rope $\frac{7}{8}$in. diameter; drum 5ft. diameter, and 18in. between flanges.—ANTIPODES.

Answer.—If we suppose a single line of road through the drift serves for the train of wagons to go and return on, and the train to be five minutes in ascending the incline, while on landing at the top four minutes are occupied in replacing the eight loaded wagons by as many empty ones, and another five minutes are occupied by the descent of the empty train, and one minute more is required for removing the rope attachment from the empty to the loaded train at the bottom of the incline, one delivery will thus occupy fifteen minutes. The eight wagons bring up at each delivery 14 tons of coal, so that 29 such deliveries will be necessary to bring up the required 400 tons, and the time needed to accomplish the work will be 29 times 15 minutes, or $7\frac{1}{4}$ hours. If we now assume the steam pressure of 40lb. per square inch, as named by "Antipodes," to be that shown by the steam gauge over and above that of the atmosphere, and his engine to be non-condensing and non-expansive, the power required under the above conditions to effect the above work will equal that of two cylinders, each 28in. diameter and 5ft. of stroke, with the steam admitted throughout the stroke, each piston being connected with a crank on the winding drum shaft, the two cranks being at right angles to each other. But a much better arrangement would be to have a double line of road through the driftway, with an empty train descending while the loaded one is ascending, and so the weight of the descending empty train and rope is utilised to assist in bringing up the loaded ones, and during the same interval of fifteen minutes, thus bringing up two trains of five wagons each, or ten wagons containing $17\frac{1}{2}$ tons of coal, instead of eight wagons with 14 tons by the single line. By such arrangement a very considerably smaller engine would suffice for doing the work. The engine might be a condensing one, and, as tending to economy, might also be worked expansively.—W. A.

PORTABLE AND TRACTION ENGINES.—Can any reader inform me whether traction and portable engines are manufactured in any of the following countries: Norway, Sweden, Denmark, Holland, Italy, Switzerland, Mexico, Canada, or in any of the States of South America, or anywhere in Australasia? Or can anyone inform me whether there is any modern geography, directory, or other book published which would give the desired information?—W. A.

SPLICING ROPES.—Will any reader kindly inform me what are the most modern methods of splicing ropes for working on pulleys, and do those methods labour under any disadvantages?—R. L. F.

EXPANSION GEAR.—Who are the makers, and where can I get a description of, Proell's automatic expansion gear?—LEARNER.

SCALING SHELL FORGING.—What is the best mode of scaling the interior of a forged shell? It is partially punched in forcing into shape.—CORT.

TEMPERING SNAPS.—Which is the best method of tempering snaps for $\frac{7}{8}$in. and 1in. rivets?—BLACKSMITH.

COPPER BOILER.—Could any reader inform me what would be the most suitable kind of copper boiler, with fire box, for $2\frac{1}{2}$in. by $3\frac{1}{2}$in. stroke horizontal engine, to be heated by a lamp or otherwise, and what would the dimensions be?—F. W. T.

CONCAVE CIRCULAR SAW.—Can any reader describe the use of a concave circular saw? It is supposed to be attached to the end of saw spindle outside of bench and driving pulleys.—H. C.

TO CORRESPONDENTS.

ERAH.—Bevel is the correct term, whether the axes (or the shafts) are at right angles or any other angle.

P. G.—Mr. Evans' system does certainly seem a strange one, and we should not expect very high economy from that proportion of cylinders, inasmuch as the fall of steam pressure at the end of the small cylinder's stroke must be enormous, and such a drop cannot take place without causing a serious loss of work. We should also expect the condensation to be very excessive in the first cylinder. It would be interesting to know the results of a reliable trial of these engines, and to compare them with those of a triple-expansion engine of about the same size.

INCRUSTATION.—We have not much faith in this method of preventing incrustation, although it has been found to give in some cases, it is said, good results. The most rational system is that which deals with the water itself. The plates would not be much harmed in any case, and if you can cheaply apply the apparatus, it might be worth a trial. There are some expensive books, such as that of Allen's, the Sheffield Borough Analyst, which gives details of the proportions of various waters in different parts of the country, which you might usefully consult.

J.—It will not be opened till the autumn.

G. A.—The blocks have been received, and will be used as soon as we can find room.

APPRENTICE.—Try aluminium.

MISCELLANEA.

GLENGARNOCK STEELWORKS.—Important extensions are about to be carried out at Glengarnock Steelworks, of such a character as to have necessitated the suspension of operations at one of the principal portions of the works. They will include the erection of three or four furnaces for making Siemens steel, and the laying down of a large plate-rolling mill. There will likewise be other extensions and improvements, so as to make the works very complete.

AMERICAN LOCOMOTIVES.—The large Roger ten-wheel engines are very highly spoken of for the work they do per ton of coal used, and for the small amount of repairs needed. The Luttgen patent damper is used on these engines, and is reputed to contribute materially to the economy of fuel, for which the engines are noted. This damper consists of a register placed in the casting at the base of the stack. Opening it softens the action of the blast upon the fire.

Rapidity of Filtration.—A limit to the rapidity of filtration has been generally adopted by the London water companies. It is represented by the passage of about 540 gallons of water through each square yard of the upper surface area of the filter in twenty-four hours, or two and a half gallons through each square foot of surface per hour. Water passed through well-constructed filter-beds at a rate not exceeding this becomes, under ordinary conditions, bright and clear.

Underground Telegraph Wires.—Mr. Patey, permanent secretary of the telegraph department of the Post Office, in giving evidence before a Select Committee of the House of Commons on the Revenue Departments Estimates, stated that in the course of years the department must look to a great expenditure on underground wires, not in substitution of the overground system, but in addition to it. The present cost of annual extension of telegraphs was about £100,000 a year, but the laying down of the first underground wires would cost ten times as much, and each succeeding underground wire would *per se* cost more than one overground wire.

Strikes in the United States.—There have been 1,000 strikes in the United States during the fifteen months ended March 31st, 1888, and of the 400,000 men engaged in them 25,000 to 50,000 are still out. As a whole about 38 per cent. or more than a third of the strikers, succeeded in getting their demands. It is calculated that nearly 10,000,000 days' work and wages were lost. The loss in wages is estimated at £2,700,000. The chief feature of the strikes (says Sir Lionel West) has been the development of combinations among employers, not only those in the same line of business and in the same locality, but among those widely separated and identified with different pursuits.

The Evils of Canal Irrigation.—In a paper on "The Evils of Canal Irrigation," read by Dr. Thornton, before the Society of Arts, the author fully admitted that the canals in India had conferred priceless benefits on the community. They had turned deserts into gardens; but they had been accompanied by three great evils. In the first place they had extensively impoverished the soil, and, in the second place, they had led to the "water logging" and swamping of the soil, owing to the absence of proper subsoil drainage. The third evil was the spread of malarial fevers—the principal cause of disease and death in India—in the neighbourhood of the canals, especially the West Jumna Canal.

Prizes for Art Workmanship.—The Council of the Society of Arts have announced their scheme of prizes for the session 1888-9. The prizes, which are valued at about £200, may be competed for by women as well as by men; and for the new session awards will be given for examples in pottery, stone carving, and wrought iron. They may be copies or modifications of existing works, or original, and the elements to be considered in making the awards are originality, beauty, fitness of treatment, and excellence of workmanship. In pottery the divisions are the body material, decoration, and stone salt-glazed ware. In stone carving, the capital of a column, with square, circular, or octagonal abacus, is the appointed subject; and in wrought-iron, grilles for protective purposes, or for street door panels, window screens, ventilators, &c. The articles in competition are to be delivered at the society's house not later than 23rd April, 1889.

Engineering Society, King's College, London.—At a general meeting, held on Tuesday, May 8, the president in the chair, Mr. P. T. Gask read a paper on the Forth Bridge. The commencement was occupied in giving some of the chief dimensions of the bridge, and trying to convey to the meeting some idea of the size of the structure by comparing it with known distances. The details were then entered into by the author, commencing with the piers, and working upwards. The mode of erecting the vertical columns by means of the rising platform was described, together with the riveting cage, &c. The author then explained the nature and amount of the stresses on the various members, pointing out the important part played by wind pressure. The paper was illustrated throughout by means of lantern slides, kindly lent by Mr. Baker, and to whom a vote of thanks was passed for his kindness in so doing. After a vote of thanks to Mr. Gask, the meeting adjourned.

New Industrial Era in India.—In a paper read before the Royal Colonial Institute by Mr. William Hunter on this subject, the author said: Coalmining on any large scale really dated in India from the opening of the East India Railway, say 30 years ago. At the commencement of that period almost the whole coal used for steam purposes in Bengal had to be imported from England. But one by one the difficulties in the application of Indian coal had been got over, and nineteen-twentieths of the coal used in Bengal, with its great railway system and its steam industries, were now raised in the country. India had inexhaustible coalfields and an unlimited supply of flux and iron ore. The problem of iron smelting in India was partly the geographical problem of distance and partly the chemical or mechanical problem of applying coal with 14 to 20 per cent of ash to the processes of metallurgy. Iron smelting in India on a large scale was now well advanced in the experimental stage, and its commercial success had been more than once asserted. Practically it might be said to have eached the point which the cotton mills had reached 30 years ago.

SELECTED PATENTS.

APPLICATIONS FOR LETTERS PATENT.

May 4th.

6640 Injectors, F. Craven, A. Craven, W. Pinder, and P. H. Stansfield, Bradford.
6653 Machinery for Screwing Holes in Metal, T. Hateley, Hednesford.
6657 Secondary Batteries, B. D. Williams, Bristol.
6668 Machine Mouldings, A. J. Bevan and Co., Bristol.
6674 Dies for Forging, J. B. Addis, London.
6680 Electric Railways, G E. Vaughan, Middlesex. (S. Trott, Nova Scotia.)
6683 Torpedoes, J. J. D. Cleminson, London.
6686 Lock Bolts and Nuts, S. de la G. Williams, London.
6689 Sifting Machines, G. Daverio, London.
6693 Engines Worked by Elastic Fluid, M. P. W. Boulton, London.
6698 Boilers, W. Forster and G. Dawson, London.

May 5th.

6700 Reversing and Distributing Valves, J. W. Donovan, Sunderland.
6701 Oil Lamp, A. Battye, Bradford.
6703 Brakes for Cycles, W. J. MacKenzie, Glasgow.
6704 Wool Combing Machines, W. H. Bailey, Koighley.
6707 Stoves, T. Craddock, Sussex.
6708 Regulating Gas Supply to Gas-engines, A. Louks, Birmingham.
6712 Machines for Pressing Bricks, J. Craven and B. Craven, London.
6718 Looms for Weaving Ribands, J. Y. Johnnson, Middlesex. (A. C. da C. Moraes, France.)—[Complete Specification.]
6727 Railway Brake Pipe Couplings, J. Waddington, London. (G. Massey, New South Wales.)
6736 Valve Mechanism for Tanks, J. Howes, Middlesex.
6739 Steering Apparatus for Twin-screw Ships, G. E. Vaughan, Middlesex (S. Trott, Nova Scotia.)
6740 Portable Electric Lamp, J. T. Armstrong and A. Serraillier, London.
6742 Steam Engines, W. L. Wise, London. (M. Oerlikon, of Zurich, Switzerland.
6746 Oil Lamps, W. Lighbody, of the firm of T. Rowatt and Sons, London. —[Complete Specification.]

May 7th.

6766 Steam Rotary Engines, F. Lang and V. Dannfeld, Glasgow.
6782 Oil Lamps, A. Batty, London.—[Complete Specification.]
6794 Mechanically Propelled Life-boats, J. C. Stitt, Liverpool.
6795 Weighing Machines, H. Pooley and H. Pooley, junior, Liverpool.
6799 Motors Forcing Fluids, J. C. Stevenson and J. Marshall, London.

May 8th.

6816 Pistons for Fluid Motor Engines, G. W. Newall, Essex.
6819 Couplings for Railway Carriages, G. W. Nash, and P. T. Lacassagne, London.
6821 Valve Motion for Pumps, J. H. Berry, Berkhampstead.
6825 Apportioning Furnace-draft for Steam Boilers, W. Fairweather, Glasgow. (The Babcock and Wilcox Co., United States.)—[Complete Specification.]
6830 Air Injectors, R. Shackleton, Bradford.
6832 Shaft Bearings, J. Hopwood, Southport.
6836 Electro-dynamic Relay for Currents, W. E. Ayrton, J. Perry and D. Cook, The City and Guilds of London Institute.
6844 Brakes for Perambulators, N. Martin, Birmingham.
6852 Governors for Steam Engines, G. D. Balls and C. Hudson, London.
6854 Sawing Machines, E. W. Snedeker, London.—[Complete Specification.]
6857 Fire Escapes, F. A. Westbrook. London.—[Complete Specification.]
6863 Steam Boilers, H. Hutinel, London.
6864 Metallic Platforms for Railway Cars, J. T. Goodfellow, London.
6865 Thermometers, E. Jones, trading as Dring and Fage, Chancery Lane.
6870 Signals of Railways, J. Servettaz, London.—[Complete Specification.]
6876 Measuring Electric Currents, H. Aron, Liverpool.
6879 Railway Rail, E. G. Chamberlain, London.
6881 Supply of Oil in Lubricators, T. Macneill, London.

May 9th.

6886 Conversion of Pig Iron into Steel, J. W. Bookwalter (G. Robert, France.)—[Complete Specification.]
6889 Dynamos and Motors, O. Firth and E. W. Crabtree, Bradford.
6893 Magneto-electric Generators, E. C. Walker, Darlington.
6895 Self-acting Stop Motions for Steam Engines, E. C. Mills, Manchester.
6907 Storage Batteries, M. Immisch, London.
6909 Dynamo-machines, E. J. Houghton, London.
6910 Electric Lighting, E. J. Houghton, London.
6911 Mules for Spinning, J. F. Poole and W. H. Poole, London.
6914 Application of Steam to Engine-power, R. Mudgemarchant, and O. G. Abbott, Islington.
6918 Anchors, J. F. Hall and J. Verity, London.
6927 Electrically Propelled Vehicles, M. R. Ward, London.
6928 Electric Switches, F. V. Andersen and J. F. Tafe, London.
6930 Twin-screw Ships, G. E. Vaughan, Middlesex. (S. Trott, Nova Scotia.)
6931 Operating the Valves of Hydraulic Lifts, W. A. Gibson, Middlesex.
6932 Meters, J. Thomson, Middlesex.
6942 Coupling, F. Offen, London.
6948 Oil Lamps, T. Macneill, London.
6953 Electric Gas-lighters, W. Southern, Liverpool.

May 10th.

6961 Electric Batteries, G. A. Nussbaum, London.
6971 Steam Boiler Furnaces, J. H. Annandale, Glasgow.
6975 Oil-burning Stoves, J. Waser and T. Davonport, Birmingham.
6983 Locks, H. T. Armstrong and W. N. Armstrong, London.
6984 Steam Boilers, A. C. Henderson, Middlesex. (A. Desgoffe and L. A. de Georges, Russia.)
6985 Switch for Electrical Tramcars, M. Immisch, London.
6987 Steam Generators, O. J. Ellis, London.
6988 Supplying Electrically-worked Vehicles with Accumulators, M. R. Ward, London.
6998 Valve for Torpedo Engines, R. Whitehead, London.—[Complete Specification.]
7000 Printing Presses, J. Richmond and W. Whiting, London.
7002 Brakes, B. J. B. Mills, Middlesex. (Guetton-Danyon and Jules des Georges, France.)
7009 Pumps, R. Haddan, London. (A. Mosser and L. Chiari, France.)
7011 Hot-air Motor, C. Wells and G. T. Hittou, Middlesex.
7013 Using Steam as a Motive-power, C. Wolls and H. H. Paynter, Middlesex.
7015 Manufacture of Metallic Tubes, R. S. Casson, London.

PUBLISHERS' ANNOUNCEMENTS.

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EDITORIAL NOTICES.

All communications for the Editor of this Journal should be addressed to 6, Victoria Station Approach, Manchester.

Communications intended for insertion in the current week's issue should reach us not later than Tuesday Evening.

We cannot undertake to return rejected manuscripts or drawings unless accompanied by a stamped and directed envelope.

Contributors are requested to write on one side only of the paper. Sketches should be sent on separate sheets.

TO ADVERTISERS.

Advertisements intended for insertion in the current issue should reach us on Wednesday morning at the latest.

THE
PRACTICAL ENGINEER.
MAY 25TH, 1888.

THE EMPLOYERS' LIABILITY BILL.

The Employers' Liability Act of 1880 will, it is almost certain, be replaced before its time runs out by the measure that was read a second time in the House of Commons last Friday. The bill has been pretty well discussed, and it is curious to note that its principle is not contested by anybody now, as the original measure was eight years ago. The truth is that it has been found there is nothing so alarming in the measure after all. Employers have not, as it was thought, been harassed into suits, as in the whole kingdom there has not been on the average one case a day set down for hearing, and of these little more than one-third have been successful. Under the present bill employers' risks are increased, but it need not be very alarming to them, especially when it is considered that they may contract themselves out of the act provided they give an adequate equivalent for its benefit in the form of contributions towards insurance, and they may cover their liabilities by policies issued by some of the many available offices.

Although, according to evidence brought before Lord Brassey's Committee, and quoted by the Home Secretary, the original Act is shown to have done little direct good, yet we hold that it has indirectly been of immense value. It has given a tremendous stimulus to the insurance of all forms of accidents to workmen. It has familiarised employers with the idea of insuring workmen employed in dangerous occupations. It has induced masters to examine the matter of insurance closely, and proved to them that the charges on this head in most businesses are but very slight. These are advantages following in train of the Act which are very pleasing to dwell upon, and workmen must regard with unmixed pleasure the extensive establishment of insurance agencies for their special benefit—a social reform which is one of the most remarkable of modern times.

It is hardly to be expected that the present measure should be passed without much criticism from the labour representatives, but we believe this has not been such as would recommend itself to the wisdom of either thoughtful workmen or masters. For example, Mr. Broadhurst thinks it is wrong for employers to cover their risks under the Act by insurance, as the inducement to take protective measures for the benefit of the workmen would thereby be lessened. The sufficient answer to this is that it is manifestly unjust for workmen to be able to say to masters what contracts they shall not make, not only with them, but with other people. Surely it would be just as reasonable for the masters to be in a position to prevent workmen taking out life policies on the ground that the motives to vigilance and prudence might be weakened. Stated in this way, the weakness of the argument is perhaps more apparent. Then, again, it has been asked, Why not make a master liable to a servant for all and every act of a fellow-servant? It is difficult enough to justify the responsibility of a master to a stranger for an act committed by a servant, but it would be intolerable to make him answerable for the acts of those with whom the injured person voluntarily associates. Another proposition made by Mr. Burt is to the effect that a workman working for a sub-contractor should be able to sue the original contractor or ultimate employer, although the latter may know nothing of and have no control over the workman. It would surely be just as reasonable to sue the magistrate on the bench. These are some of the chief objections raised to the bill, and we have mentioned them to show chiefly the significance of the temper in which the questions affecting labour are now discussed.

A CHANNEL-BRIDGE SCHEME.

The latest scheme for crossing the English Channel from Dover to Calais has just been worked out by some Creusot engineers, and consists of a bridge 20 miles long, with a platform at a height of 164 feet above the sea at full tide, and supported by piles at distances of 550 yards. The height allowed for the bridge over the Channel would allow large steamers and sailing vessels to pass freely. It would support four railway lines, beside a road for carriages and footpaths. This will be satisfactory for those who dread sea-sickness. The only trouble left them will be that of choosing their mode of locomotion—whether by railway carriage, omnibus, cab, or velocipede. Places of refuge, watch-houses, and alarm bells will be placed on each pile, with a powerful light. The authors of this gigantic scheme believe that the foundations may be constructed by means of compressed air diving bells, the depth of the strait between Calais and Dover not being, on an average, more than from 25 to 39 mètres, and in few places exceeding 50 mètres. The bridge will cost 800,000,000f., its metallic weight will amount to 2,000,000 tons, and it might be constructed in six years. The scheme will shortly be submitted for examination to an international technical committee. When this examination has been completed, the Channel Bridge Society will apply for a concession to the French and English Governments, from which it will ask for no subsidy. Under these conditions the concession might be easily granted, and the works immediately begun.

MILITARY BALLOONING.

An experiment in military ballooning was tried in Germany, last week, which consists in a new method of inflating balloons by gas produced on the spot. The apparatus which thus produces the necessary balloon gas at will resembles a traction engine, and when drawn by a team of six horses is warranted to go wherever a field-gun can be dragged. In its lower part is a furnace. This can be fed with fuel of any kind, especially wood, which is rarely unobtainable, in some shape or other, during a campaign; and above this are several parallel layers of retorts, about 30 in all, into which are thrust cases or cartridges like railway carriage warmers, filled with a mixture of zinc dust and hydrate of lime, which the action of the fire speedily converts into the hydrogen gas requisite for elevating a military *ballon captif*. To produce gas sufficient for this purpose about two hours only are required. The system thus generally described is claimed by its authors to be superior to all rival systems, as it is cheaper, quicker, and much less dangerous than any other. The cases of compressed gas with which English and other balloons are at present filled are liable to explode in course of transit from various causes, while the gas itself has frequently proved fatal to those within its reach. But the Richter-Majert method, it is claimed, is free from all these disadvantages, and, indeed, the Prussian War Minister has so far admitted the justice of these claims as to have already adopted and put in practice this gas producer, as it is called, for the balloon detachments of the army. A testimonial of this kind may be enough to recommend the apparatus to the notice of the authorities at Woolwich.

STANDARD TYPES.

Our readers will be acquainted with the facility with which railway men in America adopt standard types for almost everything belonging to a locomotive or a carriage. The latest standard type is an automatic coupler, designed by the Master Car Builders' Association, which has been suggested after careful and extensive trials of all the various forms of this piece of mechanism extant in the States. The type is said to embody every essential feature of a safe and reliable coupler, and no doubt the bewildering confusion that has hitherto existed owing to the multiplicity of designs will now disappear and give way to much desired order; and it is to be hoped and expected that future years will show a considerable reduction of fatalities and minor accidents that have been presented by past years owing to the dangerous methods of car coupling then existing.

TIMBER FOR PATTERN WORK.—II.

(Concluded from page 219.)

There are not more than half a dozen woods commonly used by pattern makers, though for occasional purposes a somewhat wider selection is made. The qualities and characteristics of these common woods will now be noticed.

Yellow pine is the king of pattern woods, being used to a much greater extent, perhaps fifty times more, than all the other woods collectively. It owes its value not altogether to its cheapness, for there are several kinds of timber which cost little more than half as much, but to the fact that it is the only moderately-priced material which is best adapted, on the whole, to the purpose for which it is employed. Thus, taking a piece of well-seasoned yellow pine, we find that we can plane it over, or can cut it with a chisel or saw, or shape it with gouges, or turn or bore it freely; that if exposed to moderate changes in temperature, or to moisture, it is not affected by shrinkage and warping to so great an extent as are many timbers, such as ash, elm, beech, &c. This characteristic of stability and permanence of form is one of great importance, because if timber does not "stand," or retain its outlines and dimensions, it is condemned for patterns where accuracy is of the first importance. Hence all large patterns and many small patterns are made of yellow pine. For the sake of economy in cost, two qualities may be well employed—the best quality, which is almost entirely free from knots, shakes, and crooked grain, for the best portions of pattern work, and seconds for much boxing up, and for a good deal of heavy core box and bottom board work.

Though pitch pine is seldom used, except in a limited degree for foundry strickles, for which its hardness renders it suitable, yet a limited quantity of red deal may be profitably employed by reason of its cheapness, which renders it suitable for the same class of work as seconds pine. Pitch pine is not suitable for general work, because it is heavy, unpleasant to work, and ill-adapted for clean withdrawal from the sand, so that in the end it would be more costly than yellow pine, without any corresponding advantage save the single one of superior hardness. Spruce and white deal are not used, though very cheap, because they do not work up sweetly; they are very susceptible to changes of temperature, warping, shrinking, and twisting rapidly, are very knotty and harsh, and are in every respect, particularly the first-named, very disagreeable materials to use. Kauri pine is perhaps on the whole the most suitable wood of this class which has ever been tried, by reason of its sweetness of working, its mellowness, freedom from liability to change its form, and because of the large scantling which it yields, so saving glueing up in heavy work. The main drawback is that of cost, due to the transit from the South Seas; otherwise it might be used to a much larger extent than it is at present.

All the trees of the genus *pinus* belong to the natural order *Coniferæ*. The yellow pine is the wood of a North-American tree, variously termed *P. mitis*, *P. lutea*, *P. variabilis*. It grows from 50ft. to 60ft. in height, and 18in. to 20in. diameter at the base, though trees larger than this are not uncommon. It is very light, weighing only about 40lb. per cubic foot, and this in itself is a distinct advantage in the case of large heavy patterns, both when in course of construction, and in the foundry, as well as in the stowing away. On the other hand, its soft texture renders it all the more susceptible to the marks and bruises of the rapping mallets in the foundry. The red deals are the produce of the Scotch fir, *Pinus sylvestris*, which flourishes in many parts of Europe, the principal shipments to this country taking place from the Baltic ports, hence called Baltic, Riga, &c., deals, the term deals denoting only the size of the scantling, as 11in. by 3in., 7in. by 2in., &c. The Kauri pine is also a coniferous tree, *Dammara australis*, a native of New Zealand, which grows to a height of 140ft. or more. It is lighter than the yellow pine, weighing about 32lb. to the cubic foot. Other allied species grow in Fiji, Australia, &c.

These are soft woods, and as such are not very durable when subject to long-continued foundry usage. Rapping, when severe and often repeated, bruises and splits them, dumps over the edges, and damages their first outlines; but for large patterns their adaptability in other respects, the straightness of their grain, their stability when properly seasoned, more than counterbalance the disadvantage of softness.

But there are a large number of small patterns upon which much labour has to be expended, and which require to be used over and over again, many scores of times perhaps, and for these the soft woods are not economical. Mahogany then is without exception the most suitable timber which is available. It is the produce of the *Swietenia mahogani*, a tree of eighty to a hundred feet in height, belonging to the natural order *Cedrelaceæ*. There is no other wood which is at once so easily worked, which stands so well in all conditions of dryness or moisture, which will bear so much rough usage, and is at the same time readily available at reasonable cost. There is no other wood, therefore, which is used so extensively for patterns for small brass work, small engine details, wheel teeth, intricate core boxes, and the like. Having stuff well seasoned and varnished, a pattern in this material will retain its shape unaltered for an indefinite period.

There are two main classes of mahogany—the Spanish and the baywood. The Spanish, which is the best, is obtained in Cuba and St. Domingo, the inferior or baywood grows on the mainland around the Bay of Campeachy and the coast of Honduras. The hardness and the price of the former are considerably greater than that of the latter; and while the Honduras weighs only about 35lb. per cubic foot, the Spanish weighs about 56lb. For the very best patterns, therefore, the last-named is much to be preferred, but for the large majority the cheaper kind is quite suitable, being much superior to pine in every respect. It need scarcely be added that in each class there are many different grades in quality, with corresponding difference in price.

With respect to the other hard woods, it is hardly worth while being troubled with them for the sake of a little cheapening in cost. Cherry is not a bad wood, but it can only be obtained in small sizes, seldom over 8in. or 10in. in diameter, hence its employment is very limited. Willow, when well seasoned, works freely, and stands very well, but it is spongy in texture, and no spongy woods are desirable for patterns: first, because they absorb moisture readily from the sand; and second, because where subsequent alterations are wanted, and the wood has become more or less dead, it is very bad stuff to cut anew.

The "American whitewood" is the product of the tulip tree (*Liriodendron tulipifera*), a native of the United States. It is wretched stuff, warping terribly. I have had it cut into thin boards, and stripped in a draughty shed for eighteen months, and then when worked up, apparently as dry as a bone, it warped more than wet pine would have done. American elm is beautifully straight, clean, and silky in the grain, and might be used as a fair substitute for mahogany. Beech and birch are hardly worth using. They are cheap enough, and will, like most of the hard woods, stand well when perfectly seasoned, but they are not freely worked, especially the latter, and time must be taken account of in an estimate of cheap timber. Being seasoned and protected with varnish, they will retain their shape and stand rough usage, but mahogany is preferable at double or treble the price. A limited quantity of elm is used for foundry strickles, for loam work, which is always wet, and elm stands moisture better than any wood.

Many of the principal English woods might be enumerated, which are at times used for patterns, especially in country shops where they are plentiful, such as apple, pear, oak, sycamore, and acacia; but it is sufficient to repeat what I have already said—that, when thoroughly seasoned, they will answer the purpose; but if there is the slightest moisture present, they will alter their forms from time to time; also that few, if any, of them are so easy to work up as mahogany, and workmen's time is of equal value with that of material. Practically, then, we fall back upon the good, well-tried yellow pine, and mahogany for pattern work.

J. H.

COMPOUND LOCOMOTIVES.

(Contributed.)

On reading the article contributed by "Dreadnought" in a recent issue on the above subject, I was pleased to find that he agreed with me that the compounding of locomotives is a decided improvement, both in economy of fuel as well as being more powerful.

In my article on this subject, which appeared in your issue of April 20th, I simply stated facts which had come under my notice of the work done by compound locomotives on Mr. Worsdell's system in comparison to those that were not compounded. Since then I have watched the working of two side-tank engines, lately built at the North-Eastern Railway Works, Gateshead—exactly alike, except that one is compounded on Mr. Worsdell's system, and the other non-compound. The space for carrying water and fuel on these engines is very limited; hence the work allotted to them is usually short journeys, or local work, so that they can replenish the tanks and coal bunkers when necessary. Both these engines were put to do the same kind of work—that is, they had to take a heavy goods train from one station to another, and there were no means of obtaining a fresh supply of either coal or water between these stations. The compound could do the journey easily, having coal and water to spare, but the non-compound had to be taken off the work, because neither the coal nor water would last the distance, both having the same quantity of coal and water to start with. This is proof positive to any unbiassed mind that the compounding of locomotives (without going into detail) means a great saving of fuel. With regard to there being undue strain by having the four wheels coupled, if an engine is built correctly—that is, the centres from driving to trailing made to a standard, with coupling rods to correspond, and the wheels turned all one diameter—there is no fear of any undue strain, at any rate I have not found it so.

There is one statement in "Dreadnought's" article which I must correct—that is, where he says in Mr. Worsdell's system the engine cannot start without admitting steam into the low-pressure cylinder. It is only when the high-pressure side is on a dead centre that the steam is admitted into the low-pressure by his patent starting valve, which works simultaneously with an intercepting valve, fixed between steam chest of low-pressure and exhaust of high-pressure, only allowing steam thus admitted to act on the low-pressure piston. Immediately a start is made the valve closes, the intercepting valve opening as soon as an exhaust takes place from the high-pressure. This is effected without any loss of time, and always ensures a start.

I cannot say anything for or against Mr. Webb's system of compounding from practical knowledge, as I have only seen them at a distance; but I have no doubt they are giving satisfaction, and great credit is due to both Mr. Webb and Mr. Worsdell for having the pluck to come out of the old groove and be pioneers of a system which has proved to be so beneficial.

NOMINAL HORSE POWER.

At first sight the above title may appear of too little consequence to be considered by a strictly practical journal, but we trust that a perusal of the following will be of some interest to even the most practical of our readers.

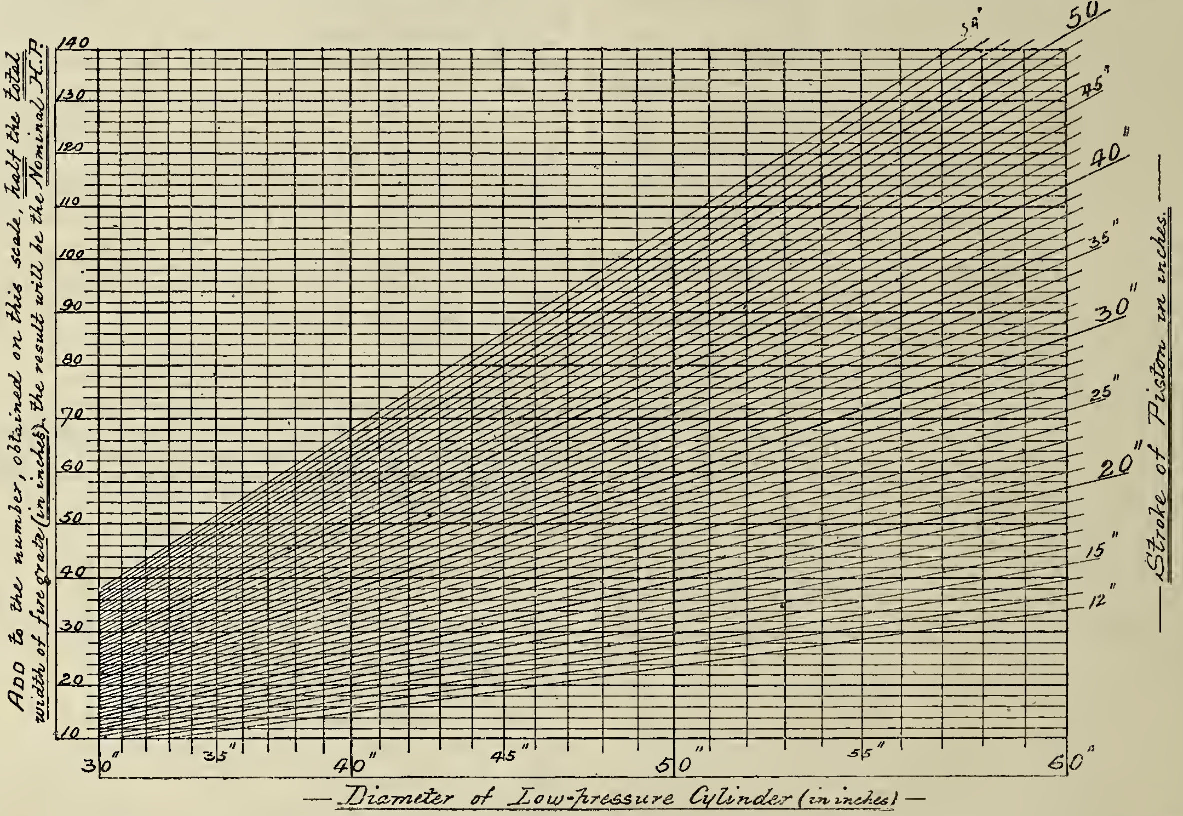
The term *nominal horse power* may be defined as being a method adopted for ascertaining the commercial value of an engine, or, in other words, a means of knowing approximately the relative size or power of an engine. It does not bear any fixed proportion to the *actual* or *indicated* horse power exerted, but is essentially a conventional term, seeing that the data necessary for obtaining the latter are, for a given diameter of cylinder, all more or less variable in their nature, whereas in most rules used for calculating the N.H.P. the revolutions of the engine and the pressure of the steam are left out of the question, whilst in others the only data necessary for the purpose being the diameters of the cylinders. As each maker adopts a rule of his own, it will be seen that for a given sized engine an appreciable difference may exist between the N.H.P.'s computed by the different makers, and, as a universal system has never been adopted, the above difficulty still exists as a stumbling-block to the unwary. This is more particularly so in land engine practice, but it is also the case (only in a somewhat lesser degree) in marine engine practice, as in the mercantile marine a common rule for the N.H.P. of an ordinary compound engine was the allowance of a certain number, generally thirty, "circular" inches of cylinder area for each N.H.P., that is N.H.P. $= \frac{d^2 + D^2}{C}$ where

d = diameter of high-pressure cylinder,
D = diameter of the low-pressure cylinder, and
C = the number of circular inches allowed per N.H.P.

This rule would be a fair one if the other factors necessary for obtaining power were proportionate to the diameter of cylinders, but it is evidently a misleading formula, inasmuch as two engines having the same diameter of cylinders may have a difference in the length of stroke of 50 per cent., and it is not strictly possible to get over this difficulty by fixing upon a given speed of piston, for we are at once brought up by the fact that here again each maker has his own idea as to the best or most economical speed of piston; hence we find engines working at speeds varying from 200ft. to 600ft. per minute, while (leaving out of the question torpedo boat machinery) a large number of engines may be found working whose piston speeds are upwards of 700ft. per minute.

With reference to the speed attained by the piston, it is manifest that the evaporative power of the boiler must bear some relation to the power obtained from or the speed attained by an engine, as it is very evident that if an engine is *short of steam* it will not attain a relatively high speed, for if we consider for a moment that the I.H.P. of an engine depends (*a*) on the mean effective pressure of steam, (*b*) the capacity of the cylinder, and *c*) the revolutions made in a given time—or we may say that, with a given mean pressure, the I.H.P. is in proportion to the number of cubic feet of steam used in a given length of time—we see that the boiler is an important factor to be considered when computing the power or capabilities of an engine.

Now, as the I.H.P. is essentially the better basis to work upon when forming an idea as to the actual commercial value of an engine, some rule which could be trusted to give an approximate value for the same would be useful.



A modern writer on marine engineering gives the following rule for what he terms "estimated horse power."

$$\text{E.H.P.} = \frac{D^2 \times \sqrt{p} \times R \times S}{8500}$$

where D = diameter of low-pressure cylinder,
p = boiler pressure,
R = number of revolutions per minute, and
S = stroke of piston in feet.

This will be found to give a fair approximation to the horse power developed by a compound engine.

But now that the *triple-expansion engine*, with its higher pressure and speed, is coming more to the front, a much greater need exists for a universal formula, which will give a basis for the commercial or buying value and at the same time an idea of the capabilities of that type of engine; and as in the mercantile marine the fees charged by Lloyd's and the Board of Trade on ships coming under their survey are computed from the registered N.H.P. of the engine, it is essential that a recognised standard should be adopted for the registered N.H.P. of engines; and therefore the Lloyd's Committee have recently issued a rule which they propose to use for that purpose.

The rule in question is somewhat similar in principle to one proposed by Mr. Macfarlane Gray some years ago and published by him in the *Artizan* (about the year 1872). The rule proposed by him is as follows:—

$$\text{Nominal horse power} = \tfrac{1}{2}\left(\frac{D^2 \times S}{630} + F\right)$$

where D = diagram of low-pressure cylinder in inches,
S = stroke of piston in inches,
F = total width of furnace (fire grate) in inches,
630 = a constant.

The objection may be made that a rule of this kind may be said to give the N.H.P. of the engine and boiler combined, but seeing that the two are inseparable, being entirely dependent on one another, this objection should fall to the ground. It may also be urged that an unjust advantage may be taken of the rule by the adoption of long narrow fire grates, but the advantage gained in that way would probably be more than lost by the decreased efficiency of the furnace.

Appended we give a graphic diagram, which will materially assist in calculating the N.H.P. of triple-expansion engines by the rule as issued by Lloyd's, and as it is interesting to note how this compares with the present registered N.H.P. of various sized engines, we give a few examples:—

Engine $\frac{11\frac{1}{2};\ 17;\ 30}{21}$ registered N.H.P. 45, having a boiler 9ft. diameter × 8ft. 6in. long, with two 34in. furnaces.

On referring to the diagram, we find that the line of stroke 21 intersects the line of diameter of cylinder 30in. at 15 on the vertical scale. To this add half the total width of grate in inches = 34in., and the result will be the registered N.H.P. by the new rule, = 34 + 15 = 49 N.H.P.

Engine $\frac{20;\ 34;\ 56}{36}$ registered as 170 N.H.P., with four 3ft. 5in. furnaces.

We get from diagram 56in. diameter, 36in. stroke = 89, which, added to ½ (4 × 41), = 82, gives us 171 N.H.P.

Engine $\frac{40;\ 64;\ 92}{60}$ with 36in. furnace, 3ft. diameter.

This being beyond the limits of the diagram, we may find the result for a diameter of 46 = $\frac{92}{2}$ and a stroke of 30 = $\frac{60}{2}$ which we find to be 50. This multiplied by 8 = $(2^2 \times 2)$ we get 400, which, added to half width of furnaces, = $\frac{36 \times 36}{2}$ = 648 gives us 1048 N.H.P.

Engine $\frac{19\frac{1}{2};\ 30;\ 52}{33}$ boiler 13ft. 9in. diameter × 10–6 long, with three 36in. furnaces.

We get as a result 70 + 54 = 124 N.H.P.

MACHINE DESIGNING.

Professor John E. Sweet has written some very useful articles on machine designing in the *American Machinist*, from one of which we extract the following :—

In all our planning and all our study there is one vital principle that is hardly ever thought of and never mentioned. We all look for the best new machine, but who to see which is to be the best old one? The mathematicians tell us which is the most perfect gear, but all their calculations are based on a new one, and no thought given to the one half or three-fourths worn out. An engine cylinder needs no counter-bore when new, but experience has shown the necessity for it when old; and short crossheads, working on long slides without overlapping at the ends, soon wear the slides concave and themselves rounding, with the result, two-curved surfaces of unequal radius always growing worse. The slides I will speak of later on. The gear tooth needs an undercut at the root as much as the cylinder needs a counter-bore. The epicycloidal may be the best form for a new gear, and the single arc odontograph for an old one.

Nearly every machine tool depends for the accuracy of its work upon the accuracy of sliding surfaces. In the best work special methods are adopted to make them true, after which they are left to fate to keep them so. Who has ever deliberately undertaken to plan and build a planing machine that should maintain perfect truth during its entire existence? The planing machine has a short table working on a long bed, the milling machine a long table working on a short bed—the lathe a short rest on long slides, and the shaper a long slide in a short guide. The tool builder would laugh at the engine builder who should run a crosshead on guides not cut away so the crosshead would overrun at the ends; and yet he makes the sliding block on the cross feed of his lathe six inches long working on a dovetail two feet long, sometimes running off at one end and never at the other. The sum of the two fitted surfaces is thirty inches. If divided equally—that is, a fifteen-inch sliding on a fifteen-inch dovetail—the two would remain true and be a good job as long as the lathe lasted. This is one of the places where for lathes of moderate size there is no excuse for anything but wearing surfaces of equal length. The designer who finds any difficulties in this that he cannot overcome has too little genius for the job. Equal length sliding surfaces can usually be employed in all the slides on milling machines, punching machines and many others, and wherever possible the use of any other arrangement is simply poor designing, to give it the mildest criticism possible. A short sliding block on a long guide invariably gets bad sooner or later, and refitting becomes necessary. The sliding-head of a shaper invariably made longer than its guide is an ever-present nuisance, and one that can be abated. The requirements call for a slide to work at all sorts of stroke, from an inch to a foot, and at positions varying as much as a foot. As now made, much of the back end of the sliding arm does not get a 100th part of the wear that the front end does, and often none at all. As a result, in many establishments the thing may be worked for a year at short stroke and in one place; then when the attempt is made to use it in a different position, it is so loose in one position and so tight in another as to be worse than useless. The remedy is easy. Make the two sliding surfaces of a length and attach the connecting rod to an immovable pin; then both ends of the slide will always overrun, whether the stroke is an inch or a foot. To provide for the varying position of the cut the head is made to slide in a sleeve, and can be drawn out to any desired length, and secured in that position by screwing up a couple of nuts.

The slide is guided in the usual way and driven by a connecting rod rigidly attached to the side or bottom, as most convenient. Instead of the slides carrying a head and tool post, it is bored out, split and provided with two binding bolts, so as to grasp the tubular arm, which, when loose, may be slid or turned in any position, and then firmly bound in that position. The diameter of the hollow projecting arm need not be much larger than the width of the tool holder—five or six inches —in an ordinary ten-inch or twelve-inch machines. The sliding arm being provided with a featherway and surrounded by a graduated worm-gear or ring feathered to it, the bar may be rotated to any angle, or adjusted endwise without disturbing or losing the angle at which it is set. A second advantage of this arrangement would be the removal of the ordinary side projections which so frequently come in the way when using the present machines.

I have not presented this so much to represent an improvement in shapers, as to show how it is possible in machines of this class to use slides of equal length, maintain their proper position, and get adjustment of tool. But you will say it is not so simple. True. Neither is a watch as simple as an hour-glass, nor a Corliss engine as simple as a Hero. Good things cost more than poor. All improvements have to be paid for. Sliding surfaces, such as those of the planing machine and slide-rest of a lathe, cannot be of equal length; then the question arises, Are they made to maintain their truth as well as possible?

PARIS EXHIBITION, 1889.

The Executive Council of the British Section announce that they are prepared to receive applications from intending exhibitors up to the 9th of next month, at which date it will be absolutely necessary to commence the allotment of space. It appears that very little, if any, more space can be given to this country, which already has a large proportion of the amount allotted to foreigners, the demands made by native exhibitors having been unexpectedly large. As regards the Industrial Departments, it is now certain that an excellent representative display will be provided: some of the classes are now practically filled up, though in others there is still room available for allotment. Nearly all the outside space available has been disposed of, so that any exhibitors wishing to show in the open air, or to erect small pavilions for themselves, must apply at once, and it is even now doubtful whether any more can be accommodated. As regards the Fine Arts Section, things are in a less satisfactory state. It is obvious that owners of pictures who may consent to lend them will not be willing to incur the expenses of transporting them to Paris, and insuring them while there; nor will our best artists, who find a ready market for all they can do at home, incur any expense in sending their pictures abroad. Unless, therefore, funds are forthcoming from some source or other, it is probable there will be no British pictures. The funds contributed by the industrial exhibitors will only suffice for their legitimate purpose—the decoration and maintenance of the industrial courts.

GERMAN COMPETITION.

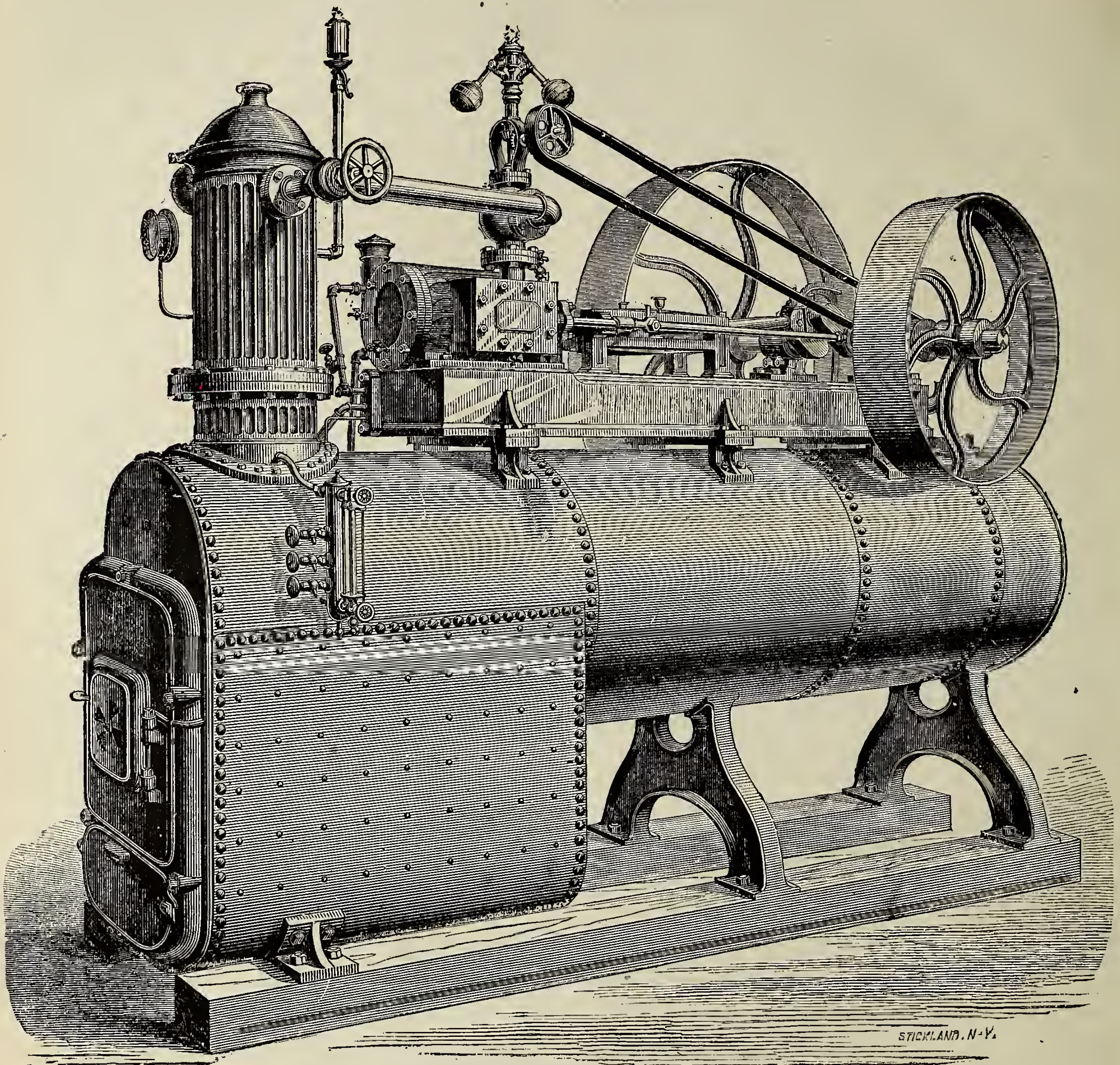
A remarkable case of German competition in scissors was brought to my notice on Tuesday, writes the Sheffield correspondent of the *Engineer.* What are known as "folding-up" nail scissors were invented by an ingenious craftsman named Mr. Thomas. They were made of fine steel and with spring arrangements which worked sweetly and well, but they could not be sold under 4s. 6d. to 5s. per pair. Prior to the expiring of the patent the wide-awake foreigner had seen his way to an imitation which could be sold at 10½d. and 1s. On the morning the patent lapsed the market was flooded with these German imitations. Of course one Sheffield-made pair will outlive six of the other, but the British public saw what seemed to suit them, and the German scissors met the market. Two pairs were shown to me the other day. Placed side by side, the difference was apparent. The German was made from steel which probably cost 1s. 3d. per stone, the other 4s. 6d. Where the Sheffield article had beautifully-wrought steel springs throughout, the other was cast, with a scrap of steel put at the end. And yet these German goods, which bear no name of place or origin, are sometimes put on cards which bear "Sheffield," and even the names of Sheffield manufacturers. Thus carded they are a gross deceit. The Germans supply them imitated at 4s. 9d. per dozen; the real article costs 3s. each to make. At one time a single Sheffield firm sent 4,500 dozens a year to Germany; they send none now. A similar tale is told of the scissor trade with the United States.

OPINION ON ENGLISH BRIDGE BUILDING.

A correspondent of *Indian Engineering*, in a criticism of the Hooghly cantilever bridge, makes the following general comments on a defect of English bridge building: "Another point where English practice differs for the worse from American is in the wind bracing. This is always adjustable in America, and never in England, even between the compression chords, so that bracing put in before the bridge is swung must be slack when the chord is compressed by the load, unless it has received an initial tension equal to the future compression of the chords, and this cannot be given by drilling the rivet holes with a "draw," even if it is supposed to be done, for the only result of that arrangement is to enlarge the rivet holes in drifting them up. I am very sure that had most of the large bridges in this country been open to tender from any country, to include design and cost of erection, very few of them would have come from England."

SEMI-PORTABLE ENGINE AND BOILER.

CONSTRUCTED BY THE AMES IRONWORKS, NEW YORK, U.S.A.


STICKLAND, N-Y.

The semi-portable engine and boiler, shown in the accompanying illustration, is now built by the Ames Ironworks, of New York, U.S.A., and though the design shows considerable difference when compared with our English practice, it has survived many years make without any material improvement being brought to bear upon it, which test is surely the best as regards workmanship and durability.

Beginning with the boiler, it is of the locomotive type, with fire-box completely surrounded by water, the bottom of the latter, forming the ashpan; the fire-box covers allow themselves to be easily removed, so as to offer when required a large opening for examining the interior of the furnace box. The fire-doors are made double, by which the draught to the furnace is regulated, and the large water space under the fire-box helps to promote a rapid circulation of the water. A prolongation of the boiler shell forms the smoke-box, which is made of the same material and quality as the boiler shell itself. To the cast-iron dome, mounted over the boiler furnace ends, are attached the steam gauge and the steam whistle, while live steam is taken from the dome to the engine. The inlet, or feed water, is furnished to the boiler by pumps from the large water space underneath the fire-box. The boilers are made to stand a hydraulic test of 200lb. to the inch, and the fore-part of the boiler is supported on two cast-iron saddles, as shown in the illustration.

To show the difference or contrast between the English and American practice still more clearly, we give the following tabulated dimensions of these boilers :—

Sizes.	Diameter of boiler.	Fire-box.			Tubes.			Weight.
		Length.	Width.	Height.	Number.	Diameter.	Length.	
	in.	in.	in.	in.		in.	in.	lb.
0	23	23	18	16	18	2	41	1,700
1	24	34	18	26	22	2¼	61	2,700
2	27	36	22	32	20	3	75	3,900
3	29	36	24	34	22	3	76	4,900
4	32	38	26	36	24	3	74	5,800
5	32	38	26	37	27	3	80	6,800
6	33	52	27	37	30	3	88	7,200
7	35	52	29	38	34	3	94	7,700
8	37	52	31	41	39	3	100	10,800
9	39	52	33	48	45	3	112	12,200
10	39	52	33	49	45	3	124	13,850

LESSONS IN MECHANICAL DRAWING.—XVII.

By Prof. A. MacLay, B.Sc., C.E.

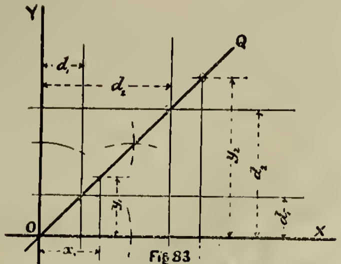


Fig 83

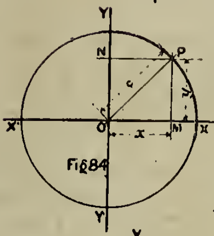


Fig 84

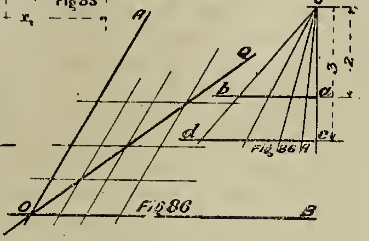


Fig 86

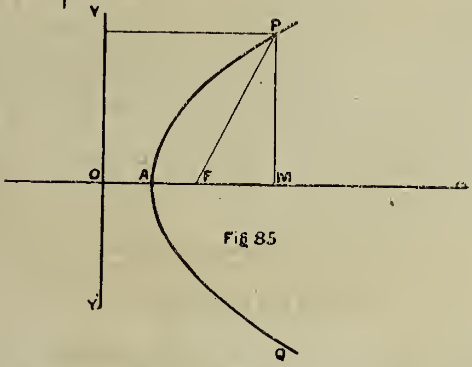


Fig 85

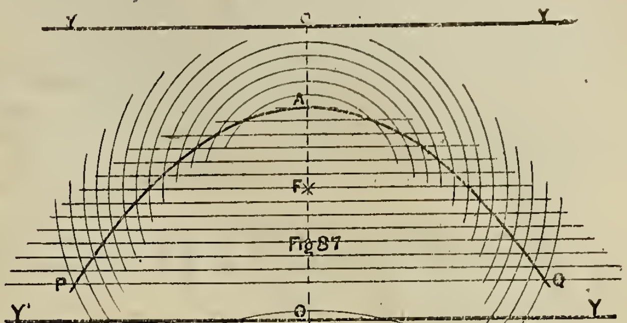


Fig 87

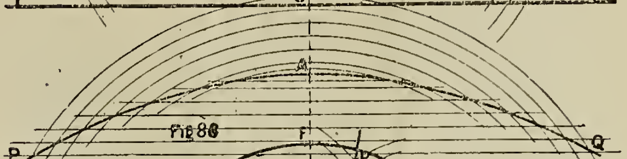


Fig 88

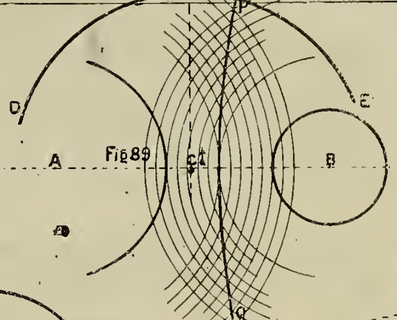


Fig 89

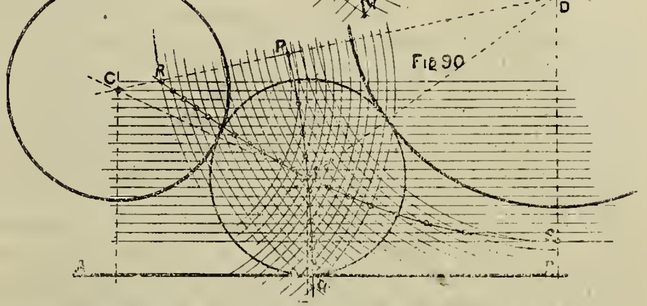


Fig 90

In this semi-portable boiler and engine, the engine bed is bolted and supported to the boiler by three pairs of cast-iron brackets. This cast-iron bed has the cylinder bolted to it, and it similarly carries the crank shaft pedestals, and slide bars and guides. The pedestals are on the improved angle system, and the slide block runs between top and bottom slide bars, the latter being lubricated from the top. The steam chest and cylinder are cast in one piece; the slide valve is worked in the ordinary manner by an eccentric off the crank shaft. A Watts governor plays on a throttle valve, and the former is driven by belting off the crank shaft. One slide works the steam ports, and the slide valve spindle is steadied in the manner shown by the before-mentioned guide bars. The piston is of ordinary construction, with metallic packing rings, and the usual connecting rod is also here retained. Two ordinary pulleys are connected on the crank shaft. The cylinder is lagged in felt, and has metallic covering attached. The feed pump is worked and fitted on the opposite side of the cylinder steam chest, and is run direct from the slide block; it is double acting, with clack valves, and the water inlet is always kept open to prevent the pumps from drying up, while the feed into the boiler is regulated by a second pipe.

Annexed are some of the main dimensions to which these engines are built:—

Size.	H.P.	Cylinder diameter.	Stroke.	Revolutions.	Flywheels.	
					Diameter.	Width.
		in.	in.		in.	in.
0	3	$3\frac{1}{2}$	6	250	9 and 20	$3\frac{1}{2}$
1	6	5	10	175	24 ,, 40	5 and 6
2	8	6	10	175	40 ,, 40	6
3	10	7	10	175	30 ,, 42	8
4	12	8	10	175	30 ,, 44	8
5	15	8	12	150	30 ,, 48	8 and 10
6	20	9	12	150	40 ,, 54	8 ,, 12
7	25	10	12	150	44 ,, 54	8 ,, 12
8	30	10	16	130	48 ,, 60	10 ,, 12
9	35	11	18	110	60 ,, 60	12 ,, 12
10	40	12	18	110	60 ,, 72	12 ,, 15

We may supplement these dimensions with the following: In the No. 3 type, the piston rod diameter $=1\frac{1}{4}$in.; crank shaft diameter $=2\frac{1}{2}$in.; crank pin diameter $=1\frac{5}{8}$in.. The No. 7 engine is estimated at 25 indicated horse power, and shows the following proportions: Steam cylinder diameter $=10$in.; steam cylinder stroke $=12$in.; piston speed $=300$ft.; connecting rod length $=3$ft.; crank radius $=6$in.; piston diameter $=1\frac{5}{8}$in.; crank shaft radius $=3\frac{3}{4}$in.; grate area $=10{\cdot}5$ square feet.

LESSONS IN MECHANICAL DRAWING.—XVII.

LOCI (*continued*): POINT PATHS.

The next class of curves (according to our division in Lesson XII., page 76) is that representing geometrical conditions.

The conditions may be given in (1) kinematic, (2) geometric, or (3) algebraic form.

1. As those for determining the path of a material particle moving in a plane, when the only thing considered is the motion, not the force producing or opposing it.

2. As those for the construction in whole or in part of some curve or figure in practical plane geometry.

3. As those which may be put in the form of an equation in plane co-ordinate geometry.

The curve may thus represent (1) the plane path of a moving point in some mechanism; hence of use as an introduction to the kinematics (or geometry) of machinery. (2) The outline or figure of some object or detail in constructive engineering; therefore useful in mechanical drawing generally. (3) The locus of an equation, useful in putting a mathematical result in graphic form.

The following simple examples will illustrate the distinction :—

The straight line OQ, in fig. 83, may represent—

1. The path of a point which moves equidistantly between the two lines OX, OY—found by drawing two pairs of parallels at distances d, and d_2, to OX and OY, and a line OQ through their intersection.

2. The bisection line of the angle XOY—found as in Ex. 40, fig. 52.

3. The locus of the equation $x = y$—found by measuring off two values of x and the same of y, as shown by $x_1 y_1$ and $x_2 y_2$.

The curve XPY, in fig. 84, may represent—

1. The path of a point which moves round the fixed point O at a constant distance OP from it.

2. A circle drawn from O as centre, with radius OP.

3. The locus of the equation $x^2 + y^2 = c^2$, in which $x =$ OM; $y =$ PM, and $c =$ OP.

Lastly, the curve QAP, in fig. 85, may represent—

1. The path of a point which moves and keeps at an equal distance from the fixed point F and the straight line YOY^1.

2. A parabola with F as focus, described by any of the geometrical methods, to be afterwards shown.

3. The locus of the equation $y^2 = 4a\ (x - a)$, in which $OM = x;\ PM = y;\ OA = AF = a$.

Exercises.

Ex. 75.—Two points are 2·25in. apart. Draw the locus of all points at the same distance from both.

Ex. 76, Fig. 86.—Two straight lines AB and AC meet at an angle of 75°. A point moves between them, so that its perpendicular distance from AB is always two-thirds of that from AC. Draw its path.

Fig. 86A shows the construction for readily finding a number of lengths in the desired proportion—2 to 3. On the line *ab*, parts are cut off in the proportion of two-thirds of those on *cd; ob* having been made two-thirds of *oc* by construction.

Ex. 77, Fig. 87.—A point F is situated at 2in. distance from a line YY^1. Draw the path of a point which moves equidistantly from F and from YY^1, or, in other words, draw the locus of centres of circles passing through the fixed point F, and touching the straight line YY^1.

Construction: Draw FO a perpendicular to YY^1, and bisect it at A. This is evidently one point on the curve. At any convenient distance greater than FA or OA draw an arc from F as centre, and a parallel to YY^1 as base or datum line. These will intersect at other two points on the curve. In the same way draw a series of pairs of concentric arcs and parallel lines, as shown in the figure, and trace a curve PQ through their intersections.

The locus in this instance is a well-known curve—the parabola, the construction adopted in fig. 87 being simply a geometrical rendering of the definition given in Lesson XII., page 77.

Ex. 78, Fig. 88.—A similar problem. Conceive the point F of the last problem to become the circle DFE, radius 1·75in., in fig. 88. Draw the path of a point which moves equidistantly between the line YY^1 and the circle DFE, or find the locus of the centres of circles touching the given line and circle. YY^1 is 3in. from C, the centre of the circle. From C draw a perpendicular CFO to the line YY^1. Bisect FO at A for one point on the curve, and at any distance greater than OA or FA draw a parallel to AB. Add the same distance to the radius CF, and with this increased radius draw an arc from centre C to intersect the parallel at two places. In this way, by a series of pairs of parallels and arcs, find a number of points of intersection, and draw the curve PAQ through them.

Ex. 79.—Draw a circle of radius 1·5in., and take a point 2·5in. from its centre. Show the path of a point moving equidistantly from the circle and the point.

Ex. 80, Fig. 89.—Take two points, A and B, 2·6in. apart. With A as centre, radius 1in., describe a circle, and from centre B draw a circle of radius ·55in. Trace the path of a point which moves equidistantly between these two circles.

Ex. 81.—To find the centre of a circle which shall touch two given straight lines which meet, and a circle.

First find the locus of the centres of circles which shall touch both lines, *i.e.*, bisect the angle between the lines. Next find the locus between one of the lines and the given circle, as shown in fig. 88. The intersection of these two loci is the centre of the required circle.

Let the two lines meet at a point A at an angle of 60°, and take a point D between the lines at a distance of 3in., as the centre of a circle of 1in. radius. Proceed to find the centre of the required circle as above described.

Ex. 82, Fig. 90.—To draw a circle which shall touch two given circles and a straight line.

Find the locus of centres of circles which shall touch the two circles; then find the locus of centres of circles which shall touch one of the given circles and the line. The intersection of these loci is the centre of the required circle.

In fig. 90, AB is the given line, and C and D are the centres of the given circles. PQ is the locus between the circles, and RS that between the line and the circle to the right. Take C, 1·75in., and D, 2·66in., from AB; also 4·25in. from one another. With I the point of intersection of the loci as centre, draw the circle which touches the circles C and D and the line AB.

THE TAY VIADUCT.

At the ordinary meeting of the Institution of Civil Engineers, on Tuesday, the 8th of May, the President (Mr. Bruce) in the chair, a paper was read on "The Tay Viaduct, Dundee," by Mr. Peter Crawford Barlow, B.A., M.Inst.C.E.

The author stated that this viaduct, which carries a double line of railway over the Firth of Tay at Dundee, was built to replace the former bridge, part of which was destroyed during the memorable storm of December 28th, 1879. The viaduct was 10,527ft. in length, and of this a length of 7,397ft. was straight and parallel to the straight part of the old bridge, the centre lines of the two works being 60ft. apart. At the southern end, the lines of railway branched westward towards St. Fort, and eastward towards Newport, the junction being made upon brick arching of sufficient width for two double lines of railway. The northern, or Dundee, end of the viaduct formed a curve of 21 chains radius, and joined the existing railway, which was here parallel to the river. The gradient of the line was 1 in 762, falling from the southern shore to the navigable channel, where four spans, each with a clear headway of 77ft. above high water spring tides, were provided, and from this point a down gradient of 1 in 113·75 was maintained to the northern end. Out of a total of 85 piers, the foundations of 73 were formed of a pair of cylinders placed from 32ft. to 26ft. apart from centre to centre. In the case of the largest spans, the cylinders, which were of wrought iron, were 16½ft. in diameter at their upper ends, and were enlarged by means of conical sides to a diameter of 23ft. at their bases. With these areas, the total weight of the structure and rolling load combined produced a pressure of from 3 to 3½ tons per square foot upon the foundations. Special pontoons were constructed by Mr. Arrol, the contractor, for the purpose of affording a stationary platform from which to conduct the operations of sinking the cylinders to the required depth into the river bed. The platforms, which carried all the necessary machinery—steam cranes, dredger, winch, concrete mixer, hydraulic and centrifugal pumps, diving gear, &c.—consisted of rectangular iron tanks, fitted at the four corners with cylindrical legs resting on the bed of the river, each leg having two hydraulic rams, by means of which the platform could be raised or lowered at will. In the centre portion of the platform, the surface of which was maintained at a height of about 2ft. above high water, two rectangular openings were provided, to admit the cylinders in their respective positions. The cylinders were prepared on shore in annular divisions, of a size that could be easily handled and conveyed to the pontoons, where they were bolted together. The excavation was then proceeded with by dredging the sand from the interior, and, when necessary, additional weight in the form of cast-iron blocks was added to force the cylinder down to the required depth. The whole was finally filled with concrete, composed of six parts of gravel and sand to one part of Portland cement, passed through the water in specially-designed hopper boxes. The internal circumference of the cylinder had previously been lined with a ring of brickwork 18in. thick, in order to add weight and stiffness during the sinking operations. The foundations were mainly upon sand, but at the shore ends rock and red clay were found. At this stage of the work, the cylinders being about 1ft. above low water, the pontoons, which admirably resisted the force of the gales so prevalent in this part of the Tay, were floated away to the site of the next pier. According to the requirements of the Act of Parliament, the foundations were tested with a weight 33 per cent in excess of the possible dead and live loads combined, and for this purpose 30,000 cast-iron blocks, each weighing half a ton, were required. The results of these tests, which were personally checked by Major Marindin, R.E., on behalf of the Board of Trade, were very satisfactory, the greatest depression recorded being rather under 1¼in. for a ton per square foot. The whole of the 73 piers formed with cylinder foundations were subjected to this test, the aggregate weight representing 92,000 tons. The remaining piers on the north and south shores were of brickwork, and adapted to the requirements of the situations in which they were placed. After testing, the piers were continued by brick cylindrical shafts filled with concrete, and, to protect the brickwork from the action of the tide during construction, the work was enclosed in temporary iron caissons. At 18in. above high water the two brick shafts were joined by a horizontal member of brickwork and concrete resting on cast-iron girders. This connecting piece was 7ft. deep, and carried at the lower part a string course of granite running round the pier. Upon each brick shaft an octagonal iron frame was secured by eight wrought iron tie bolts, each 2½in. in diameter and 20ft. in length, anchored down into the brickwork by cast-iron plates. These frames, which served to distribute the weight uniformly over the brick shafts, formed the base to which the superstructure of the pier was riveted. Maintaining the octagonal form, two hollow pillars were constructed of plates, stiffened by horizontal bracing internally, and by vertical T irons and channel irons externally, and were united at the top by a semi-circular arch. The mean stress upon the ironwork of the piers was about 2 tons per square inch.

After a careful examination of the girders still remaining on the old bridge, it was decided to use them in the new viaduct, placing them on the outsides under the parapet, and adding to each span two new intermediate girders. To transfer the old girders to the new piers, special pontoons with telescopic columns, actuated by hydraulic rams, were used. The columns were adjusted to the underside of the span to be removed, the rising tide completed the lift, and the whole was floated across to the new piers, which were adjacent and opposite to the old ones; when in position, the old girders served as a platform on which to run out the new girders. Rails having been laid on the top members of the old girders, the new ones were brought out on travellers designed for the purpose, and finally were lowered into their places by hydraulic power. The large girders forming the 13 spans in the central portion of the river were built upon a staging near the south shore, and as each complete span was finished, it was floated on pontoons and landed upon the brickwork portion of the piers already prepared to receive it. The entire span, weighing about 514 tons, was afterwards raised by hydraulic machinery to the full height, the superstructure of the piers being completed as the work proceeded. These girders, of which there were two to each span, were 245ft. in length, of "hog-back" form, 20ft. high at the piers and 29ft. high in the centre. They were connected by bracing 16ft. above the rails, and by flooring, which was built up of plates and channel irons, forming a corrugated decking 16in. deep. The flooring of the smaller spans of the viaduct was of a similar type, but instead of channel irons, single steel plates were pressed into a trough form, 8in. deep, with a length equal to the width of the viaduct, 25ft. 6in., and riveted to each other by a cover-plate joint. Above the decking, throughout the whole length of the viaduct, a parapet of lattice work was riveted to the outside girders, and between it and the rails timber guards were placed, hollowed out to receive on one side a 9in. water pipe, and on the other a gaspipe and telegraph wires. Provision was made for the effects of expansion and contraction at about every 500 feet on the straight part of the viaduct, and in the permanent way there were corresponding fished expansion joints. Between the expansion joints the girders were connected together in groups. To provide against any possible tendency in the girders to travel in the direction of the gradient, at thirty-eight places along the viaduct the girders covering one span in each group were firmly bolted down to two piers. The total expansion provided for was about 5ft. in the length of the viaduct. The rails of the permanent way were laid in chairs upon cross sleepers, the sleepers being embedded in ballast in the corrugations of the decking.

The actual work in the river was commenced in June, 1882, and the viaduct was opened for public traffic on the 20th of June, 1887.

TORPEDO EXPERIMENTS AT PORTSMOUTH.

What is understood to be the last of the long series of experiments conducted by the Torpedo Net Defence Committee against the Resistance hulk at Portsmouth came off last week. The object of the experiment was to test the endurance and efficiency of wooden booms for supporting the nets, and more particularly the value of certain improved heel attachments under the shock of heavy charges of gun-cotton exploded in close proximity. The Torpedo Committee had long recommended the substitution of steel booms for the heavy and cumbrous wooden booms now in use, and their recommendations have been strongly supported by the way in which the Bullivant steel booms have passed through an exceptionally severe ordeal. But as the Admiralty entertained an unwavering faith in the superior utility of timber, it was determined to ascertain by a specially-devised test whether a change of material was absolutely essential to perfect protection. As, however, the ordinary service booms had failed to give satisfaction under trial, the booms now operated upon were made considerably heavier and stronger. Their diameter had been increased from 10in. to 12in.; they extended 33ft. from the ship's side, and, with their gear, each spar weighed about a ton.

A previous experiment having demonstrated that a heavy charge may be exploded midway between the booms without injury to either the spars or their fittings, it was resolved to locate the torpedo immediately beneath the head of the boom, whereby the full effect of the detonation and of the upward rush of water would be felt at the point farthest from the ship. The charges were simultaneously exploded, the result of the combined shock being felt several miles away. The centre boom on the starboard bow was completely severed at the head, but the whole of the new attachments remained intact; while on the other side the consequences were precisely the reverse—the centre boom being blown from its connection with the ship, thereby ruining the defence, but remaining otherwise uninjured. The practical conclusion from the experiment appears to be this—that with wooden booms something must inevitably succumb under the strain of a severe attack.

ASSISTANCE TO BRITISH TRADE.

A Consular report from Cayenne and Surinam says: A letter from a commercial firm in London, enclosing circulars, and requesting the Consul to give the names of leading merchants to whom they might supply their goods, having been received at the Consulate, a reply was sent "that the circular had been passed on to what was considered to be the leading firm in the class of goods alluded to, but that German firms supplied better, or at any rate cheaper, articles, and so made up as to appear better, by which English firms were handicapped. Also that it seemed useless for consuls to urge English merchants to send out travellers, as the Americans and Germans do, and that both in Cayenne and Hayti trade had gone out of our hands by the superior energy and push of foreigners. Not only catalogues similar to the small slips enclosed, but large German books of prices and samples of goods, were in merchants' hands, and that the first requirement to enable our English commerce to maintain its well-earned ascendancy was English travellers speaking the language of the country they were sent to visit." Consuls are often reproached by merchants at home for not pushing their interests abroad. Whilst fully prepared to do all in their power to protect British commercial interests, it is impossible for them to do any material good unless the British trader adopts the same measures of pushing his goods as is done by merchants of other nations.

ORIGIN OF ARTESIAN WELLS.

The sedimentary rocks, in their great thickness, inclose a succession of water-sheets or water-levels occupying distinct stages, and extending, with uniform characters, under whole countries, like the strata to which they are subordinated. It is proper to remark here that by the term water-sheet is not meant a real bed of water, lodged in a cavity, between solid masses that serve as walls to it, but water filling the minute interstices or the cracks of a rock. Continuous and regular in sand, these sheets are usually discontinuous and irregular in limestones and sandstones, in which the water only occupies more or less spacious fissures. When natural issues are wanting, human industry is able, by boring, to make openings down to the subterranean waters, which it causes to jet up to the surface, and sometimes to a considerable height above. The thought of undertaking such works is a very ancient one. The Egyptians had recourse to them 40 centuries ago; and they were executed in France in 1126, at Artois, whence the name of artesian wells has been given to them. The water-levels of the cretaceous strata, from which the French artesian waters issue, are not always of advantage; but in the north of France and in Belgium they constitute the most formidable obstacle which miners have to encounter in reaching the coal-beds.

A striking confirmation of the theory of the source of supply of the artesian waters has been discovered at Tours, where the water, spouting with great velocity from a well 110 metres in depth brings up, together with fine sand, fresh-water shells and seeds, in such a state of preservation as to show that they could not have been more than three or four months on their voyage. Some of the wells of the Wady Rir have also ejected fresh-water mollusks, fish, and crabs, still living, which must, therefore, have made a still more rapid transit.—*Popular Science Monthly.*

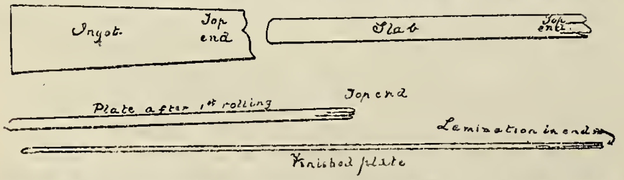
CORRESPONDENCE.

We do not hold ourselves responsible for the opinions of our Correspondents.

THOSE BLISTERS.

To the Editor of "The Practical Engineer."

Sir,—As most of your practical readers will know, blisters in iron are due to slag or cinder getting between the layers when manufacturing the iron. The cinder is not expelled in the hammering and rolling process, but rather extends over a larger area, in proportion to the amount of hammering or rolling the plate has to undergo. These blisters, from which no brand of iron can claim freedom, are, fortunately, not dangerous, and once the plate is worked into form without inconvenience, there need be little fear as to the durability of the plate, as they are often quite local, and when dressed off rarely or never extend; they are, however, occasionally found of sufficient area to warrant the renewal of the plate. The largest I ever found was about 2ft. 6in. by 1ft. 6in. by $\frac{1}{16}$in., to fully $\frac{1}{8}$in. thick in a treble-best flue plate; indeed it was the only blister I have found that led to the renewal of the entire plate. On the introduction of steel plates we were fully assured that no such thing was possible in steel, and for a number of years we were practically free from them, but I am sorry indeed to say that recently I have fallen in with many steel plates, by different makers, that are badly laminated or blistered; but in steel plates the defect is not due to slag or cinder, but to carelessness and parsimonious practices. Steel plates must now be made cheap, consequently as little must go to waste as possible. The metal, in process of manufacture, is in a molten state, and consequently all slag rises to the top of the ingot, which is therefore somewhat rough and uneven. The ingot goes under the hammer, and is made into a slab—the slab to the rolls, and each process tends to increase the irregularity of the top end of the ingot, as shown in sketch, and unless a considerable portion of the scrag end of the slab is cut away, lamination exists in that plate made from the top end of the ingot, and this shows itself more in flanging than any other process, although it is often found when testing strips of plate ends. It is very seldom found in the edge of plate, and as ends of plates are seldom worked beyond merely bending, the lamination is seldom seen in the boiler shop. Steel makers try to ignore them, but I have made more than one steelmaker admit that it is due to not cropping the slab sufficiently far in to remove the defective portion.—Yours, &c.,



Chalkline.

THE STEAM ENGINES AND BOILERS BILL.

To the Editor of "The Practical Engineer."

Sir,—I crave your indulgence to be allowed to make some few remarks anent correspondence on the above subject. I have read the whole series of letters from the commencement, some with amusement, and others with much interest and real advantage, and although your correspondent, "J. R. W.," relates some ugly cases, yet I would venture to say that he would have a difficulty in finding such cases where boilers are under the supervision of any bona-fide insurance company, one of the benefits of such being that ignorant attendants soon receive information enough from any inspector (if he will only take it) to check such absurdities.

As to your correspondent, "Ignorance," he decidedly has a leaning to the poor heroes of the handbag, as he styles them, and would apparently annihilate them and give the preference to boiler attendants, and with it the immense responsibility of corrosion, deterioration, and other probable evils—in fact make him responsible for boiler accidents totally, and its consequent penalties. I am much afraid "Ignorance" has lost his head, if he imagines the "good times" are coming when the "good men" are likely to accept such responsible burdens. One would almost imagine that good times and good men are almost a *future* possibility. As to boilers being cleaned every four or six weeks, the more common practice is four or six months, so that "Dry Season's" statements are still a possibility, and that such things do occur is no supposition, but an actual fact. And now, sir, your correspondent asks: "How are we to know the inspector is competent or truthful in his reports?" I am almost inclined to make a demand on the future, but instead, I will ask "Ignorance" what any inspector will gain by giving an untruthful report? I will tell him what he will lose, and that is his situation, as it is a very common occurrence for boilers to be examined by different inspectors annually, which would very soon ferret out such looseness or falsity in examination or reports, unless they are all equally sinful (rather a grim pill to swallow); and as to their competency, I will leave it to your readers to judge whether any insurance company of standing, being commercial concerns, are likely to employ any such individual, at the risk they incur of £ s. d., independent of other very serious consequences, such as loss of reputation, &c., really the vital substance of a company's success. As to the examination made by the hero of the handbag, I find it difficult to believe that any inspector would be so insane as to lay himself open to such a charge, which, I venture to say, would soon be made by any owner of an insured boiler, and which, being made, would mean instant dismissal by any respectable chief engineer, and he would deserve it. As to what companies did with regard to sending circulars to employers of enginemen I know not, and care less, as I imagine such employers would doubtless understand what was necessary to accept for their own welfare in the way of advice, and I can, at the same time, vouch the opposite for one of the largest, if not the most important company in existence, one, indeed, who would not be troubled with such bogus or doubtful "heroes of the handbag" as your correspondent, under a very suggestive *nom de plume*, would infer; and with respect to some men in large manufacturing concerns seeing further through a half-inch steel plate than nine-tenths of the inspectors, I would venture to doubt, not in a personal sense, but for what it is worth in the abstract to any sane individual; but if I spoke from experience, I should almost coincide with "Ignorance," and say that this was one of the reasons why employers plead confidence in the insurance companies and their inspectors.

The number of members in the House implies to a great extent what "Ignorance" evidently does not know—that insurance companies have reduced explosions to such a minimum that they did not consider legislation necessary in that particular direction.—I am, very truly yours,

May 19th, 1888. One of the Heroes.

To the Editor of "The Practical Engineer."

Sir,—In a previous issue your correspondent, "Ignorance," enunciated the proposition that corrosion and deterioration ought to be put down to the ignorance of the attendant, without any demonstration of its truth, and one of the objects of my letter of the 7th inst. was to obtain this demonstration, with, however, no result beyond the question, "Would I, or any other sensible man (thanks for the compliment), blame the man in charge after reporting the defect to his superior?" which I respectfully contend has nothing to do with the theory put forth, and, therefore, leaves it unsubstantiated.

With regard to the question of the ability of the inspector *versus* that of the attendant to see a defect in a plate, I would reply that, however intelligent an attendant may be, he never has the opportunity of acquiring the same experience (which is the pivot on which the whole thing turns, as your correspondent admits practically) as the inspector; therefore the inspector's opinion will continue to have the greater weight, and until a term of service as inspector forms one portion of an engineer's training, inspectors will continue to be higher authorities on the questions relating peculiarly to the working of steam boilers than attendants can possibly be.

I am very glad your correspondent agrees with me as to the advisability of engineers, &c., holding certificates of competency. A great deal has been made of the tendency of boiler attendants to recklessness, particularly the overloading of safety valves, and at the most two or three specific cases have been cited of this actually occurring, one in point being that mentioned by "Ignorance" of his finding a piece of cast-iron pipe hung on the safety valve lever. But here, again, particulars are lamentably wanting. What could be done in the dinner hour to dispense with the necessity for this overloading? These cases are exceptions, and are no evidence of the ignorance of attendants as a class. Just the same things might be said and proved of quite as many boilerowners, and though the master might not be cognisant of the fact in the case in question, there are cases where it is done with the owner's knowledge, so that it does not follow that by removing uneducated attendants irregularly loaded safety valves will become things of the past. Contrary to admitting that the majority of the attendants in charge of small boilers are themselves too ignorant of the dangers to inform anyone else, I beg to assert the contrary. I assure you that it is the minority, and a very small minority, too, who are so ignorant. One would almost suppose, from the style of most of the letters written on this subject, that it is the peculiar mission in life of some persons to show that boiler attendants are more prone to the lighter forms of insanity than any other class of persons.—Yours, &c.,

21st May. J. S. S.

THERMO-DYNAMIC ANALYSIS OF THE GAS ENGINE.

To the Editor of "The Practical Engineer."

Sir,—Mr. Guthrie is, I think, somewhat unkind to inquirers like myself. He describes an engine with certain novel features; my interest is keenly aroused, and I seek all the information I can get, anxious to know if it is a real engine, and if so where it can be found and what it can do? This seems to annoy the inventor, who does not "feel disposed" to refer to what he considers his "personal and private business arrangements." Not only are such matters airily waived aside, but I am called upon to apologise, but for what is not very clear. It is not an "inaccuracy" but an absolute fact that *it seemed to me* that the patent was abandoned; hence the word "apparently" was used. As to whether it did or did not appear to others in the same light, I know not. I might, of course, apologise for the structure of my mind, but this would hardly meet the case; and Mr. Guthrie having shown clearly that I was grossly ignorant of his intentions, will, I trust, refrain from crushing altogether a humble inquirer like myself. Among the "glaringly inaccurate" remarks to his hand, Mr. Guthrie has made some unfortunate selections. We know that beyond a certain point of dilution gas will not burn. We also know that with an explosive mixture the explosion is not instantaneous. As soon as combustion has begun in a diluted but explosive mixture, the products H_2O and CO_2 dilute still more the unburned gas remaining, and this accounts in great part for the observed discrepancy. The inconceivably small molecular commotion necessary has already taken place, and I do not know of any experiments which would lead us to think that further commotion would cause further inflammation. Violent agitation is, however, already existent in present engines, whatever it may be worth. It is only by crediting me as well as himself with belief in the unproved efficacy of such agitation that his charge of inconsistency can stand.

The experiment with the poker, which I presume your correspondent has himself made, has given some remarkable results. I have repeatedly tried the same experiment, with gas of various towns, and could never get a light below a bright red. This is, however, a matter of fact, which each can verify for himself. Relying on my own experiments, which gave a very bright red as necessary, and knowing that the heat of the cylinder must be kept considerably above this to give certainty of action, I felt justified in saying a white heat would be necessary.

An air jacket is in itself a good idea, but calculation shows that with the low specific heat of air an immense volume will be required to effect the cooling, and the pump, with its friction, must be proportionately large. The large volume of air required for keeping the cylinder cool cannot all be used in combustion. A large part would apparently have to be rejected into the air, carrying with it the heat put into it by compression in the pump; but as Mr. Guthrie's explanations have to a certain extent put a new complexion on the matter, perhaps further explanations might clear this up also.

The promised results will be awaited patiently, but with interest by all. In hopes of seeing them soon, I remain, yours truly,

May 19th, 1888. W. A. Carlile.

ACTION OF WATER ON GALVANISED IRON.

To the Editor of "The Practical Engineer."

Sir,—After reading your report of a paper read on the above subject before the Boston Society of Civil Engineers, I would ask your permission to state the following case, so as to get the opinion of some of your chemical readers.

I work with a Manchester firm who look on their workmen as so many hired machines, and think it waste of money to make any provision for the health or comfort of their workmen during meal times. The managament is done by telephone, and the works are in the charge of an inexperienced man, whose principle duty is to keep down working expenses by a "penny wise and pound foolish" principle. Looking at the waste of time it took to boil the water for the men's breakfast, he would erect a wrought-iron boiler. He did so, and found when done it would hold no water. Having warmed by friction that part of his body from which his inspiration comes, he got an idea: he decided to have the boiler galvanised, and then it would be tight and give no more trouble. This was done, and pipes connected ready for use. Some of the men suggested that it might have a serious effect by the water acting on the zinc. His reply was characteristic; he did not think of that, but it would have to do now, as it cost too much money to be thrown away.

Now, will some of your readers say if it is injurious to health to have tea or coffee made with water boiled in a galvanised boiler. I believe that some of us are now suffering from the effects of it.—Yours, &c.,

19th May, 1888. Slide Rest.

QUERIES AND REPLIES.

Compounding.—We have a pair of high-pressure engines which we want to make compound by chainging one cylinder. Will some reader say what amount of condensing water per minute will be required, and the size of pond; also what is the best automatic cut off for D valves? The cylinders are 14in. diameter by 24in. stroke, and make 83 revolutions per minute; cut off at 10in. Boiler pressure 60lb., but not more than 50lb. on the piston. Port opening 6¾ by ⅝.—J. A.

Answer—Assuming that 50lb. above atmosphere or 65lb. absolute is got on high pressure piston, I should recommend "J. A." to replace one high-pressure cylinder by one 28¼in. diameter, and the stroke as before, with a short slide valve at each end, arranged to cut off at ⅝ of the stroke. This arrangement would drive the same load as the engines are now driving with half the quantity of steam, working it down to a prossure of 5lb. absolute. The pond required would be about 20 yards by 30 yards by one yard in depth, each particle of water passing through the condenser once a day, the basis of calculation being: injection 60° Fahr., ejection 100° Fahr. The best cut off for D valves in the high-pressure cylinder would be to cut them out altogether and put in piston valves, with a noiseless twist motion.—J. S. S.

Tempering Snaps.—Which is the best method of tempering snaps for ⅞in. and 1in. rivets?—Blacksmith.

Copper Boiler.—Could any reader inform me what would be the most suitable kind of copper boiler, with fire box, for 2½in. by 3½in. stroke horizontal engine, to be heated by a lamp or otherwise, and what would the dimensions be?—F. W. T.

Concave Circular Saw.—Can any reader describe the use of a concave circular saw? It is supposed to be attached to the end of saw spindle outside of bench and driving pulleys.—H. C.

Humidifyers.—Will some of your readers who have practical experience with the working of "Humidifyers" in weaving sheds kindly inform me as to their effectiveness? also give maker's name and approximate cost.—D. W.

Ejector Condenser.—Can any practical reader give me any information about Morton's ejector condenser, and say if the same could be applied with advantage to a 20 h.p. portable engine, there being a plentiful supply of water just at hand, but a long way to be always hauling coal? I do repairs at a saw mill engine in the country, and thought something like the above would save much coal in twelve months. I should also like to know the probable cost and rule as to size of injection pipes.—Young Fitter.

Machine for Stamping Nails.—Will one of your readers give me the name of a good firm to manufacture a special press for stamping out nails?—F. C.

Thin Plates.—Can any of the readers of your practical and valuable paper inform me if it is possible to get thin sheets of iron or steel (say 20's gauge) as large as 8ft. 6in. by 4ft. 6in.? If so, where?—Chalkline.

TO CORRESPONDENTS.

Apprentice.—The best book on the subject is Seaton's Manual of Marine Engineering, and you could not do better than study it.

G. G.—We cannot say which is the best lubricant. See the correspondence that has appeared on the subject of "heated necks" in the last two or three issues of this journal.

Apprentice.—Calculate the amount by assuming the steam to be discharged at a pressure of, say 10lb. absolute. The volume of a pound of steam at this pressure is given in all tables of pressure and volume of steam. The second part of your question is very indefinite. We do not understand what the air has to do with it.

K.—The force varies as the square of the velocity.

MISCELLANEA.

New Railway.—The new line from Ilkley to Bolton Abbey Station was opened on Wednesday week for traffic, having been previously inspected by Major Marindin, of the Board of Trade. It is expected that the remainder of the line—from Bolton to Skipton—will be completed by July.

New Filament for Incandescent Lamps.—It is said that a Russian has discovered a filament to be used in incandescent lamps, capable of standing so high a temperature that from 2 to 4 times as much light can be secured from a given expenditure of power as has been claimed by the Westinghouse and Edison companies. If this be true, it will at once double the capacity of existing plants.

The Manchester Ship Canal.—Across Stiggins Island, half a mile below Barton Bridge, a new cutting is being made by the Ship Canal contractor to divert the river, and thus afford tipping accommodation in the old bed of the Irwell, which runs round the island. A steam navvy has been got to work on the island. The cutting of the canal has been commenced at Flixton, near Hulme's Bridge. There are now seven locomotives and about 1,000 men at work on the Eccles and Barton sections of the canal.

The Institution of Civil Engineers.—The council of this institution have awarded a Telford medal and a Telford premium to Mr. Edward Hopkinson, M.A., D.Sc., for his paper entitled "Electrical Tramways: The Bessbrook and Newry Tramway." The formal presentation will take place at the first ordinary meeting next session, on the second Tuesday in November.

Powerful Tool.—The hydraulic forging press of the Atlas Works at Sheffield is said to be the most powerful tool ever made. It exerts a nominal pressure of 4,000 tons, but its actual maximum pressure is considerably greater. Three furnaces of 100 tons separate capacity, heat of the metal, and two 150-ton travelling cranes convey and manipulate the forgings.

New Office in the Portsmouth Government Yard.—A new professional officer has been experimentally appointed at Portsmouth yard in the shape of a surveyor of stores. His duties are confined to the receipt of stores of all kinds, as he will be held responsible for the quality of all goods supplied for the use of the establishment. In order that the work may be efficiently performed, he is authorised to consult with the various departmental officers. Mr. Batt, assistant constructor, has been entrusted with the duties, and should the office give satisfaction surveyors will be appointed for the other yards.

The Floods on the Mississippi.—This year's flood of the Mississippi river has been the most destructive within recollection. For 100 miles south of Keokuk the river averages seven miles wide. Every levee or dyke between Keokuk and Alton has been destroyed. In Alexandria (Missouri) the only spot above water is not large enough to hold fifty people. One levee, which cost $750,000, has been washed away, exposing one hundred and twenty-five thousand acres to a flood of water. The damage by the flood to the crops is estimated at three million dollars, and to buildings a million more.

Railway Accident Returns.—A return has been published of accidents and casualties, as reported to the Board of Trade, by the several railway companies in the United Kingdom for last year. There were 33 persons killed and 647 injured, as against 12 killed and 696 injured in 1886. There were 31 collisions between passenger trains, by which 25 persons were killed, and 244 passengers and 14 servants were injured, and 42 collisions between passenger trains and goods and mineral trains, by which one servant was killed, and 6 cattle-drivers and 24 servants were injured. Two cases are mentioned of trains coming in contact with projections, 58 cases of trains leaving the line, two cases of trains travelling in the wrong direction, 23 cases of trains running into stations or sidings at too high a speed, and 116 instances of trains running over cattle or other obstructions.

Mona's Queen.—The Isle of Man Steampacket Company's steamer Mona's Queen, which was built by the Barrow Shipbuilding Company, has been in the hands of the Naval Construction and Armaments Company during the past few months, and with the view to the acceleration of her speed Mr. A. B. Bryce Douglas, managing director of the latter company, has added new superheaters to her boilers and new paddle-wheels, as well as having the engines thoroughly overhauled. She made her trial trip a fortnight ago going to the Clyde. Her engines developed 6,239 horse power, with 44 revolutions per minute. Previously the highest rate of revolutions obtained was 40, and that only for a short time. The Mona's Queen steamed for six hours continuously, at the rate of 20¼ knots per hour. It is anticipated she will now be able to steam from Fleetwood to Douglas in less than two and a half hours.

Torpedo Discharger.—The double-tube arrangement, the invention of Captain May, for discharging under water torpedoes without the use of T pieces, has not realised the high expectations formed of it when it was tested on board the Severn at Portsmouth. Up to the present time the most satisfactory results have been obtained from the modified Polyphemus gear fitted to the Mersey, as 60 per cent of hits have been secured up to a speed of 17 knots. At higher speeds of the ship the lateral oscillation communicated to the guide bar by the vibration of the vessel has diverted the torpedoes either forward or aft, according to the variation of the bar at the moment of their leaving the ways. Captain Wilson is understood to have devised a means of still further improving the Polyphemus tube, whereby the erratic direction of the weapon will be remedied. The new gear will be fitted to the Mersey, after which the ship will be sent to Portsmouth for experiments.

Engineering Society, King's College, London.—At a general meeting, held on Tuesday, May 15th, the president in the chair, Mr. Long read a paper on high-speed engines. The author commenced by pointing out when high-speed engines might be advantageously used for driving dynamos, ventilating fans, centrifugal pumps, &c. The principal differences between an ordinary double-acting horizontal engine and a high-speed engine were then pointed out, and the author passed on to a description of the chief types of such engines. The Westinghouse engine is of the ordinary reciprocating kind, with two single-acting vertical cylinders. The cranks being opposite one another, the reciprocating parts balance each other. Parson's high-speed engine depends on the fact that when one circle is made to roll inside another of twice the diameter, any point on the circumference of the smaller will trace a diameter of the larger. A few other types of engines, including Rigg's, were described, and after a vote of thanks to the author the meeting adjourned.

SELECTED PATENTS.

APPLICATIONS FOR LETTERS PATENT.

May 11th.

7021 Nut Locks, W. Whitehead and H. Shaw, Leeds.
7035 Electrical Coupling, W. E. Langdon, Derby.
7042 Mules for Spinning, W. Hurst, of the firm of R. Threlfall, London.
7050 Shaft Couplings, H. H. Lake, London.
7061 Boilers Lined with Lead, I. S. McDougall, J. T. McDougall, R. K. Hartley, and T. Sugden, London.
7063 Printing Machines, J. Elliott and R. Elliott, London.
7065 Radial-tube Steam Boilers, E. S. T. Kennedy, London.—[Complete Specification.]
7066 Motor Engines, P. Gibbons and A. S. F. Robinson, Berkshire.

May 12th.

7069 Brick Moulding and Pressing Machine, J. Anderson, Newcastle-on-Tyne.
7073 Auxiliary Motor to be Used with Steam Engines, J. Jackson and P. A. Martin, Birmingham.
7074 Transmission of Power, H. W. Houlden, Doncaster.
7077 Combined Fire-box and Water Tube Steam Boiler, J. Mills, Manchester.
7086 Ventilator, W. G. Creed, London.
7094 Axle-boxes for Railway Vehicles, C. Smith and A. Oldham, London.—[Complete Specification.]
7099 Hydraulic Lifts, W. Carter, Middlesex.
7100 Type-writing Machines, H. H. Lake, London. (H. D. Gause, United States.)
7101 Brake Blocks, L'Ancienne Société, J. G. Bideau et Cie., and E. E. Michelin, London.
7105 Compasses, W. C. Cooper, London.
7107 Double Gauges for Steam Boilers, T. Huut, London.

May 14th.

7111 Electrical Couplings, J. H. Davies, London.
7115 Safety Appliance for Hoists, R. Middleton, Yorkshire.
7121 Sight Lubricator, J. Hogg, Northumberland.
7122 Propeller for Driving Safety Water Cycle, C. Jackson, Staffordshire.
7128 Signalling on Railways, J. Shakeshaft, Northamptonshire.
7131 Regulating Electric Currents, Sir W. Thomson, Glasgow.
7150 Lubricators, Sir J. Vogel, London.
7154 Propelling Boats, J. R. M. Mallett, London.
7159 Amalgamating Metals, S. T. Dahl, London.—[Complete Specification.]
7170 Furnace Grates for Steam Boilers, C. D. Abel, London. (E. Langen, Germany.—[Complete Specification.]

May 15th.

7172 Condensing Apparatus as applied to Marine Engines, W. R. Renshaw, Staffordshire.
7174 Packing for Pistons, F. Walker, London. (C. H. Gaeger, Prussia.)—[Complete Specification.]
7187 Treating Ores for the Obtainment of Gold, J. B. Hannay, Glasgow.
7189 Steam and Gas Generator, J. Hindley, Manchester.
7194 Fire-boxes for Steam Boilers, R. E. P. Craven, Leeds.
7200 Axle-box, J. W. Williams and H. W. Williams, Bristol.
7201 Operating Railway Signals, F. B. Hart, London.—[Complete Specification.]
7203 Extinguishers for Lamps, S. A. Johnson, London.
7207 Lubricators, G. W. Brown, London.—[Complete Specification.]
7215 Welding Metals, W. Burnham, London.—[Complete Specification.]
7218 Cutting Screws in a Lathe, W. A. S. Benson, Kensington.
7219 Artificial Fuel, H. Williams, Westminster.
7222 Power Looms, A. L. Skinner, London.—[Complete Specification.]
7227 Engines, M. P. W. Boulton, London.
7229 Stone-breaking Machine, V. F. Schubert, London.—[Complete Specification.]
7232 Ventilating Railway Carriages, J. T. Ernest, J. H. Stephens, C. R. Bisbee, and R. S. Marvin, London.—[Complete Specification.]
7235 Gas Stove, D. H. Saul, London.—[Complete Specification.]

May 16th.

7237 Testing Miners' Safety Lamps, W. Patterson. Newcastle-on-Tyne.
7239 Locking Bolt, E. R. Baller, Birmingham.
7245 Coated Metal Plates, T. Price, Glamorganshire.
7247 Mules, L. Glover, London.
7252 Indicators for Railway Carriages, N. Pirrie, Germany.
7255 Dredgers, W. Y. Fleming and P. Ferguson, Glasgow.
7256 Electric Glow Lamps, F. Rowling, Yorkshire.
7257 Preventing Loss in Smelting Ores, F. Fenton, Yorkshire, R. J. Partridge, Westmoreland.—(James Woolford, France.)
7262 Bicycles, J. Sheldon, Middlesex.
7269 Type-writers, W. P. Thompson, Liverpool.—(The Standard Type-writer Manufacturing Co., United States.)
7271 Lamps for Paraffin Oil, J. Crowley, Liverpool.
7279 Washing Ores, Richard de Soldenhoff, Middlesex.
7284 Valves, M. Forestier, London.—[Complete Specification.]
7287 Gas-heated Boilers, H. J. Davis and H. C. Turner, London.
7289 Pipes, W. Allan, London.
7290 Railways, E. H. Morton and G. Taylor, London.
7292 Utilising Waste Steam, C. A. H. Laillet, London.

May 17th.

7294 Joining of Sheet-metal Tubes, J. Wilhelm, of the firm of E. Fries and Co., London.
7296 Screw Stocks, J. Bentley, Birmingham.
7299 Rolling Metal Rods, J. T. King, Liverpool. (A. J. Day, United States.)—[Complete Specification.]
7301 Regulating Electric Currents, Sir W. Thomson, Glasgow.
7313 Barring Engines, D. Whitehead and H. Haworth, Burnley.
7314 Metallic Packing for Piston Rods, W. Whyte and J. Allen, South Shields.
7329 Crushing Ores, W. Teague and D. Wellington, London.
7332 Conductors of Electricity, H. Edmunds, London.
7333 Electrolytes for Electric Batteries, R. McKenzie, London. (H. Weymersch, France.)
7339 Fire-bars for Furnaces, S. Bamforth, London.
7354 Steam Generators, J. Twibill, London.—[Complete Specification.]
7355 Field Telegraph, Richard von Fischer Treunfeld, London.
7357 Clinical Thermometers, T. P. C. Crampton, London.

PUBLISHERS' ANNOUNCEMENTS.

BACK NUMBERS of "The Practical Engineer," from the commencement, can be obtained at either of our offices in London or Manchester, or by order of any Newsagent.

Vol. I. (bound), containing Nos. 1 to 44 inclusive, from March to December, 1887, price 6s. 6d., can still be obtained by order from any Newsagent, or will be forwarded, carriage paid, from either of our offices on receipt of the amount by postal order or stamps.

Numerous complaints having been made to us by Subscribers of the difficulty they experience in obtaining copies of the *Practical Engineer* in certain districts, we have to state that the Journal can be obtained by any Newsagent through the ordinary trade channels, and no difficulty should therefore exist in obtaining copies by order of any Newsagent.

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&c., &c., &c.

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EDITORIAL NOTICES.

All communications for the Editor of this Journal should be addressed to 6, Victoria Station Approach, Manchester.

Communications intended for insertion in the current week's issue should reach us not later than Tuesday Evening.

We cannot undertake to return rejected manuscripts or drawings unless accompanied by a stamped and directed envelope.

Contributors are requested to write on one side only of the paper. Sketches should be sent on separate sheets.

TO ADVERTISERS.

Advertisements intended for insertion in the current issue should reach us on Wednesday morning at the latest.

THE PRACTICAL ENGINEER.

JUNE 1st, 1888.

HORSE POWER OF MARINE ENGINES.

The term nominal horse power, as applied to engines, has become so utterly useless and meaningless, that there has sprung up a very strong desire within recent years for substituting some other term that shall have a more scientific basis and a real commercial value. For such purposes as Lloyd's and other shipping registries a really satisfactory method of practically determining the horse power of a marine engine has become indispensable, and the only method that seems at all to answer these requirements must be one proceeding on the basis of *indicated* horse power. It is evident, from the merest superficial consideration, that no rule involving an approximation to indicated horse power can be perfectly general in its application, owing to the variations of steam pressure, boiler power, speed, and many other disturbing elements; and hence all that can be done is to give a sort of average power which would be developed by the engines under what may be called normal conditions.

The North-East Coast Institution of Engineers and Shipbuilders recently appointed a sub-committee to consider and draw up a report on this subject, and if possible to devise a rule that should answer commercial and other requirements best. The sub-committee has done its work very creditably, and we have its report before us at the time of writing. The rule that has been devised takes into account four factors, two of them being peculiar to the engine, and two to the boiler. These are the diameter and stroke of low-pressure cylinder; and heating surface of, and steam pressure in, the boiler. Everything else about the engine and boiler being assumed as normal, it is evident that the horse power developed will depend on these four factors, and on these only. The result given by the rule is denominated *normal* indicated horse power, and the rule itself is as follows:

$$\text{N. I. H. P.} = \frac{(D^2 \sqrt[3]{S} + 3H) \sqrt[3]{P}}{100}$$

where D = diameter of low-pressure cylinder in inches (if there be more than one low-pressure cylinder, D^2 = sum of the squares of the diameters);
S = stroke of piston in inches;
H = heating surface of boilers in square feet;
P = working boiler pressure in lbs. per sq. in.

The report details the conditions that are considered normal, and without describing them fully, which would take up too much of our space, we may say that they are briefly: (1) The steam is always expanded down to the same pressure; (2) the expansion is effected with the same efficiency at all pressures; (3) the piston speed varies as the cube root of the stroke; (4) the boilers are constructed according to fair average practice; (5) the efficiency of the mechanism is constant. The normal conditions here briefly indicated are frequently very widely departed from in actual practice, but even then the result is not very seriously affected, as is shown by examples in the report. In deducing the rule it was found (1) that the mean pressure on the pistons reduced to the low-pressure cylinder is equal to, with a very slight error, 5·6 times the cube root of the initial pressure; (2) that the actual loaded trial trip value of the piston speed may be taken as 144 times the cube root of the stroke in inches; and (3) that the power of the boiler may without sensible error be assumed as equal to heating surface multiplied by cube root of pressure and divided by 16. Given these conditions, it is easy to see how the rule quoted above has been obtained. The horse power of the boiler should, of course, be the same as that of the engine, but where this agreement does not occur a mean is taken by adding the two together and dividing by 2; hence the plus sign in the numerator of the rule. This step is quite an arbitrary one, and is only justified by the results thus obtained conforming to the conditions previously stated.

For paddle engines the rule is altered by making the 3 in the numerator into a 5, and the 100 in the denominator into 160. The power of marine machinery, as thus ascertained, has some real scientific and commercial value; but if users desire a number that shall compare more nearly with the old nominal power, they may divide the above result by 6, thus:—

$$\text{Nominal horse power} = \frac{\text{N.I.H.P.}}{6}$$

The thanks of engineers all over the country are due to the North East Coast Institution for taking this matter up in a serious spirit, and it would be well if they would carefully examine into its working, in order to see if it is entirely satisfactory, or if it can be improved by some slight alteration in form, or, perhaps, in the constants.

THE TRANSCASPIAN RAILWAY.

The Samarcand section of the Transcaspian Railway has been opened, and General Annekoff is extolled highly in some quarters for carrying out the enterprise of constructing 1,000 miles of railway under very great difficulties in the course of three years, at the comparatively small cost of 43,000,000 roubles. It must be borne in mind, however, that the railway is but of a temporary character, and many more millions of roubles will have to be spent on it before it is perfected. The bridge spanning the Oxus consists of four parts, and its total length is two miles, of which 972 fathoms are of wood. The bridge is built on piles and arches. This railway connects at once all the trade routes converging in the Black Sea with the Caspian by means of one line of railway. From Baku there is direct water communication with Usun Ada; from that point the Transcaspian Railway connects the aforesaid important routes with the East *via* Askhabad, Merv, and the ancient Oxus or Amu Darya. Although called into existence by military requirements, the railway has been constructed by pacific means, and will be used largely for developing the trade with Central Asia. At present the trade between Russia and Central Asia amounts to about 30,000,000 roubles, and consists principally in the exportation of natural products, and the importation of Russian manufactures and grain.

SOME PRACTICAL NOTES ON MARINE ENGINEERING.—XV.

(*Continued from page* 231.)

Design and Construction of Boilers.—IV.

TUBES (*continued*).

The welding rolls consist of two grooved rollers, revolving rapidly in contact at the outside edges of the rim. The grooves are of the same diameter as the outside of tubes. Exactly in the centre of the groove, on the end of a long rod or mandril, is a die, of the diameter of the inside, over which the tube is forced, and at the same time welded by means of the rollers. A few seconds only are sufficient to weld a tube 22ft. long. During this process the length is greatly increased, a 14ft. plate coming out as a tube about 15ft. 6in. long. Another point of great importance is the exact diameter of the die on the end of the mandril. These are measured in 32nds of an inch, and vary according to the thickness of the material, so that every tube is weighed and marked in pounds before being put into the welding furnace, and where there is a difference in weight of a few pounds, say five or six, a different die is used, $\frac{1}{32}$ larger or smaller as the case may be. In connection with this it may be mentioned that in case of the tube sticking to the mandril and stopping the machine, a safety or snapping-block of cast iron is fitted to the driving shaft of the machine, and this block, being the weakest part, breaks in two, and saves further damage. Immediately after the tube has been welded, and before being removed, the edges formed by the junction of the rollers are cut off by means of a large knife, a man taking hold of each end and drawing it rapidly over the surface. The tube is now straightened by being passed between two conical revolving rollers, placed at an angle, and as it works itself through, all the bends and twists inseparable from the great heat of the furnace are easily taken out, and all the scale and roughness removed; while as it passes along, with a large piece of sandstone resting on it, it becomes quite smooth, and has a finished appearance.

The next process is that of cutting into lengths. This is done with a revolving cutter, against which the tube is pressed by means of a lever. They are now taken to another machine, and the ends faced up to remove the compression formed by the cutter. The swelling of the ends, $\frac{1}{16}$in. to $\frac{1}{8}$in., is now done by forcing a mandril into the tube by hydraulic pressure, giving it the required permanent set. They are now each separately tested under a pump, at a pressure from 400lb. to 500lb. per square inch, after which the ends are softened by being heated to a dull red heat, and cooled in ashes, in order that they may easily stand the work of expanding when being fitted into the boiler. After being coated with oil or other substance they are ready for delivery.

The stay tubes are screwed at each end with a fine thread, to nine or eleven threads per inch.

COMBUSTION CHAMBER CROWNS.

These are generally flat, and supported by girders, secured with screwed stays, fitted in the same manner as the side plates. Sometimes they are supported or hung from the shell plates, locomotive fashion; they have also been made cylindrical and self-supporting, corresponding with the bottom.

When they are made in the latter form the limiting formula for furnaces must be applied for ascertaining the thickness of plate. When wholly suspended from the shell plates the size of stay will be in proportion to the area supported, as given in a previous table.

When taking into account the crushing strain on the tube plate, it is sometimes thought desirable to partially support the crown from the shell, in which case the area of the stay is such as to take up the excess of strain on the tube plates.

If girders only are used, they are made in accordance with the following formulæ—

Lloyd's:

$$\frac{C \times d^2 \times t}{(L - p) \times D \times L} = P \text{ working pressure.}$$

Where C = 6,000 if there is one stay to each girder,
9,000 if there are two or three stays to each girder,
10,200 if there are four stays to each girder.

Where L = length of girder,
p = pitch of stays,
D = distance apart of girders,
d = depth of girder at centre,
t = thickness of girder at centre.

All these dimensions to be taken in inches.

Board of Trade:

$$\frac{C \times d^2 \times t}{(W - p)\, D \times L} = P \text{ working pressure.}$$

Where C = 500 for iron, 550 for steel, when there is one supporting bolt;
750 for iron, 825 for steel, when there are two or three supporting bolts;
850 for iron, 935 for steel, when there are four supporting bolts;
W = width of combustion chamber in inches;
p = pitch of supporting bolts in inches;

D = distance apart of girders in inches;
d = depth of girder in inches;
t = thickness of girder in inches;
L = length of girder in feet.

These girders are usually made of iron, as this material has been found to last better than steel for this particular purpose, and the reduction in size, if made of steel, would be so little as not to be worth taking into consideration. They are generally in two plates, placed side by side, with a square washer under the nut of the stay, and as the pressure is all in one direction, the strain approximates to that of a beam supported at each end and uniformly loaded.

The section $t\,d^2$ is that which is to be determined to resist the pressure; then if we know the other dimensions and working pressure P, $\frac{P \times (L - p) \times D \times L}{C} = t\,d^2$.

The plates forming the girder are from $\frac{5}{8}$in. to 1in. thick, and the depth about ten times the thickness. Sometimes they are one solid forging, thicker than the two plates combined and not so deep, swelled where the stays pass through. This construction is usually adopted where the height is limited and the steam space stays come in the way. Taking a combustion chamber, say 40in. wide, and entirely supported by girder stays, having the stays pitched 8in. by 8in., and a working pressure of 160lb., we have

$$\frac{160 \times (40 - 8) \times 40 \times 8}{10{,}200} = 160 = t\,d^2.$$

Now, suppose two 1in. plates in each girder, then $\frac{160}{2} = d^2$, then d = 9in. nearly; that is, the girder would be 40in. long, by 2in. by 9in. deep.

By the second formula, $\frac{160 \times (40 - 8) \times 8 \times 3{\cdot}3}{850} = 159$, or say 160, the same as before.

THE GLASGOW EXHIBITION.

FROM OUR SPECIAL CORRESPONDENT.

After having made an extended visit to this Exhibition, we have no hesitation in saying that in the Mechanical Section the exhibits are numerous, interesting, and instructive. To the general public not specially acquainted either theoretically or practically with the principle of engineering science, the extensive display of machinery cannot fail to throw some light on the vastness of this branch of our manufactures, and those who require to use artificial power in their everyday business will find many splendid examples of the latest and best application of specialties from which they will be able to make selections fitted to their own wants; while, from observation, the skilled workman will not fail to extend his knowledge and lay in a store of information to bear fruit for the benefit of himself and mankind generally.

Glasgow and the Clyde being what we may term the home of marine engineering, and this branch forming one of the staple industries of the district, it would naturally be expected that many samples—either in whole or in part—would be found illustrating the advancement made in the construction of machinery and other mechanical appliances on board ship, and in this expectation the visitor will not be disappointed. He need not, however, expect to see huge engines and boilers erected the same as they are erected on board ship, or as completed in the manufacturers' works. Marine engines are for the most part large and of great weight; they are, therefore, like the vessels for which they are intended, illustrated by model, drawing, or photograph. This, of course, refers more particularly to the larger class of work; but representing the smaller class there is an excellent full-size engine, constructed by Messrs. Ross and Duncan, of the latest and most approved design, fitted up complete, as though on board the vessel, with one of Mr. Duncan's patent propellers attached. The valve easing doors are removed so as to show the slide valves, and the engine is worked by a neat little launch engine placed alongside. The shipowner will find many specialties which are absolutely necessary for the safe and economical working of a steamship, among which we may mention steam steering gears; engine-room telegraphs; fans for ventilation and forced draught; pumps of all kinds for bilges and ballast, &c.; while in detail each branch of manufacture adds its quota to the wants of the shipowner and marine engineer.

The steel industry is well represented by both local and English firms, and the application of the products of the steelworks to the kindred branches of engineering is well illustrated by the exhibits. There are full-size steel plates for boilers, &c., shafts for engines, castings in steel applicable to nearly every part of an engine or machine, and numerous examples of the severe tests put upon the material at the makers' works in order to conclusively prove that it is suitable for the purpose intended; while there are also huge ingots of great weight, out of which the plates and forgings are made. There is also a good representation of the copper industry, which at the present time, owing to the syndicate having caused the large advance in the price of this metal, and also on account of the late disastrous bursting of a steam pipe on board the s.s. Elbe, will be of more than ordinary interest. Metals and alloys of various kinds illustrating their adaptation to special purposes are also exhibited. In other branches of engineering there are steam engines of various types, machines for facilitating the production of work, while those interested will find many of the working parts shown on one or other of the stands.

The steam engines may be divided into two sections, those for land and those for marine purposes, but, strange to say, there are no locomotives. We notice many fine specimens of the former, notably one by Messrs. Hick, Hargreaves, and Co., of Bolton. There are many small engines at work, some to show the working parts, others driving small machines, or pumping, &c. A study of the horizontal land engines and of the vertical marine ones will well repay the trouble. By comparison of the design and of the features adapting each for its own work there is much to be learnt. In the details generally the difference is most marked. Connecting rods, eccentrics, and especially valve motions (well adapted for stationary horizontal engines), are of no use whatever for marine ones. The large number of the former that are fitted with Corliss valves and automatic cut-off gears; the toothed gearing in connection with these parts or for the governor, and which appear to answer their purposes so well on the various exhibits, and which we presume are examples of the latest and best types, with improvements up to date, were tried years ago, and utterly failed when applied to marine engines. Comparisons of this description are of an exceedingly instructive kind, though they may not lead to any practical issue; years of experience alone can teach us these lessons; yet it is by such reasoning that our ideas are led into a right groove, and divide one section of engineering from another. Again, when we look at Stand No. 475, and see Mr. Proctor's patent mechanical stoker, we cannot help wondering why this useful invention, so successfully applied to stationary boilers, has not been more generally adopted on board ship. The advantages of a good mechanical stoker are numerous. Among the principal may be mentioned the prevention of smoke and economical consumption of fuel. There is also, in conjunction with this stoker, a very simple arrangement for moving the fire bars for the prevention of clinkers. There are very few working parts, while these are always accessible, and not likely to get out of order. We observe that one of these stokers is applied to one of the boilers supplying steam to the engines in the Exhibition.

Among all the exhibits the most universal application of any one kind is, perhaps, to be found in the many uses to which a pump is put. In the factory, the mine, or on board ship it is essential. In the Exhibition there are vertical, horizontal, and centrifugal ones, all of which are to be seen at work. Nearly all are manufactured as a specialty, and in this direction the ingenious application of steam is becoming more and more marked, and each advancement appears to be in the direction of simplicity and arrangement of working parts, together with their accessibility for easy overhaul and repair. A glance at some of the exhibits shows how simple a thing a pump may be, more particularly if required only for displacing large quantities of water or other liquid—that is, for other purposes than feeding boilers. The Pulsometer, as shown on Stand No. 507, is a good example of this. It is a marvel of simplicity—a mere casting in one piece—fitted with two suction and delivery valves, and a ball valve for regulating the admission of steam. There is even no exhaust steam to contend with, as its economical use forms one of the leading features of the pump, and one of the first points of practical importance is that it does not require any lubricant. The out-of-the-way positions in which it may be placed, owing to the absence of external working parts, are really astonishing, and on that account it could be used where many other pumps would not answer. For mining, irrigation, and harbour works, also for salvage operations, this specially applies; while for ballast and bilge pumping on board of a vessel it is well adapted. The amount of space taken up by these pumps is indeed small compared with the amount of work done, and to look at the great number displayed on the stand, occupying comparatively little room, will give a good idea of what can be done as far as economy of space is concerned. Of course in many cases space is of no consequence, but for marine purposes, as an instance, it may be everything. It will be noticed that the gun-metal ball valve which is placed on the top of the casting is in a separate small piece, joined to the main casting by a flange and bolts in the ordinary way. This allows of repairs being easily effected, and the ball renewed if such should be found necessary. The suction is placed on the very bottom; the discharge is well up on one side, and has the usual flange connections. The suction valves are on each side of the suction pipe, and the discharge valves are close to the discharge outlet. These are the only connections required. For long lifts it is advisable to have back-pressure head valves and foot valves. For all ordinary purposes cast-iron wears well, but for chemical work, where the acids are likely to affect this metal, the whole casting is made of gun-metal, and the valves to suit. There are three kinds of suction valves in use, each suitable for special kinds of work. First, the ordinary indiarubber valve, with brass seat and guard; second, a hinged clack valve, faced with wood or rubber; and third, the ball valve. The latter are of iron, in iron seats, or gun-metal with phosphor-bronze seats, or rubber with iron cones and gun-metal seats. As stated, the amount of space taken up is very small. Thus, a Pulsometer, lifting 900 gallons per hour (which is the smallest size made), occupies only 10in. by 10in., and is 18in. high; while one lifting 52,000 gallons only takes up 56in. by 42in., and is only 80in. high. The lifts or height to which the water can be pumped vary from 40ft. to 70ft., depending on the pressure of steam supplied. The suction lift may be from 6ft. to 10ft. for the small size, and 10ft. to 15ft. for the larger ones.

PLANING versus CHIPPING.

The use of approved mechanical appliances not only decreases the cost of production by saving labour, but also results in greater efficiency and in a better finish. It has, however, been a work of time for shipbuilders and boilermakers to realise this truth, nor can it be said that it has yet met with universal acceptance. In no department is this possibly so true as in that of planing machines. Not many years ago neither the fore and aft nor athwartship edges of plates were planed. The early rules for the construction of iron vessels issued by Lloyd's Register for British and Foreign Shipping and by the Underwriters' Registry for Iron Vessels did not make even the planing of butts compulsory, the former stipulating they were to be "closely fitted by planing or otherwise," and the latter expressly mentioned "jumping," requiring that when butts are "jumped, the ridge formed by jumping is to be chiselled off the inside, the ridge outside to be hammered into the seam." These "jumped" butts were considered by conservative mechanics to be superior to carefully fitted planed butts, but the prejudice has, we believe, long disappeared. Still for years comparatively little planing work was executed in shipbuilding yards, at first it being strictly confined to butts; indeed in many cases the machines in use would not permit of the plates being planed lengthwise. The result was either very roughly finished landing edges, or an excessive amount of hand labour in chipping and cutting the outside edges of the shell plating prior to the seams being caulked. Time, however, works great changes, and now there are comparatively few shipbuilders who do not have all plate edges planed which have subsequently to be caulked; and in the best equipped establishments there are planing machines capable of dealing with any length of plate up to 28ft. Machines have also been designed at which both a butt and a seam edge can be simultaneously planed, and in course of time machines of this design will doubtless become popular, as permitting a greater and more economical output of work.

Although the chipping of tee and angle bar edges is not usually such a formidable task as cutting and chipping plate edges, still this work means a considerable amount of labour, which can also be avoided by the use of suitable planing machines. Indeed, a number of the larger shipbuilding yards have already had plant of this description supplied by Messrs. Scriven and Co., the well-known makers of shipbuilders' and boilermakers' machinery. This firm have a special planing machine, invented by one of its members, by which either two of the edges of angle or tee bars can be planed simultaneously, or only one edge, as may be required. Where caulking edges are not so prepared, there may not be the same efficiency in the work; at all events the actual manual labour in chipping and caulking is trebled or quadrupled.

Closely allied to planing machines are hole-cutters, of which there have been a few different designs successfully introduced, both for cutting circular holes for side lights, &c., and the ordinary manholes. These machines are portable, and usually worked by hand, although for heavy work in some instances steam power has been applied. They have not come into such general use, owing partially to the fact that in some cases powerful machinery is provided for punching or shearing large holes, and also because in shipbuilding establishments, where only dead weight carrying steamers are built, there is not much work for them. Where at present circular holes have to be punched out with a ¾in. punch, and then cleaned up, or the side light holes have to be cut out entirely by hand, a mechanical hole-cutter of a good make would, however, be found to be in the vast majority of instances decidedly economical.

In closing, a word of caution may be fittingly given as to the working of planing and hole-cutting machines. The men in charge should be fairly intelligent, or well supervised. This is not always so. In one instance an exceptionally large steamer was being built with the shell plating arranged to have the longitudinal edges of the inside strakes planed and fitted carvel fashion with outside connecting strakes. In a vessel with the shell so plated, and all the edges bearing closely, the strain on the rivets must be lessened, and this was the principal reason for incurring the extra expense for material and labour. Unfortunately a number of the plates, through the carelessness of the man at the planing machine, were planed with bevelled edges, and had to be packed up, or the plates condemned. Similarly, sometimes too much material is planed off, resulting in open butts, or partially unfair holes, owing to the platers drawing the plates to lessen the opening at the butts, or, in cases of strict supervision, to the condemnal of material. It is thus a mistaken notion to consider any workman good enough to place in charge of a planing machine.

STRENGTH OF ROPES.*

The author has experimentally investigated the quality of workmanship, the strength, the extension, and the elasticity of ropes and cables, round and flat, of hemp, of aloe, and of iron and steel wire. The apparatus, constructed in 1880, for these investigations consists of a horizontal hydraulic press, and a steelyard of three levers, with a sliding weight on the last, by which resistances of from 1 to 60,000 kilograms, or 60 metric tons, can be measured. Higher pressures, up to 100 tons, are indicated by means of a pressure gauge on the body of the press. Specimens submitted for trial are fastened by winding each end of the rope on a grooved pulley, specially designed, the extremity being knotted and secured against a fixed edge in the groove. The power is applied by means of a ring applied to a separate edge in the groove. The piston of the press is 11·81 inches (300 millimetres) in diameter, and that of the piston rod is 4·33 inches, with a maximum stroke of 31·5 inches. The pressure is about 100 atmospheres. The useful length of cable for testing is about 13 feet. The weight of the apparatus, exclusive of the pump, is 7¾ tons.

Ropes and cables, of white hemp and tarred hemp, were procured for testing, imported from Italy and Russia, in addition to those obtained in France, of long fibre, handspun, with from fifty to fifty-five twists to the yard; 1½ yard of rope yarn sufficed to make 1 yard of cable. A selection of results of testing, for elongation and tensible resistance, is given in the annexed table.

Results of Tests of Ropes.

		White Hemp.		Tarred Hemp.		White Manilla	
Circumference before rupture	inches.	4·33	4·33	4·25	4·25	3·94	3·94
Circumference after rupture	,,	3·86	3·74	3·70	3·74	3·27	3·39
Length tested	feet	32·8	32·8	32·8	32·8	32·8	32·8
Length measured for testing elongation	,,	13·1	13·1	13·1	13·1	13·1	13·1
Elongation	inches.	27·2	28·3	25·6	26·4	23·2	22·8
Section of the four strands	sq. ins.	0·819	0·819	0·819	0·819	0·819	0·819
Section of the piece		1·490	1·490	1·481	1·481	1·246	1·246
Resistance	tons.	7·94	7·43	5·22	5·64	5·44	5·96
Resistance of the four strands per sq. in.	,,	9·78	9·02	6·35	6·86	6·60	7·24
Resistance of the piece per sq. in.	,,	5·27	4·95	3·49	3·87	4·32	4·76
Weight of the whole piece tested	lbs.	17·4	17·6	18·7	19·6	15·0	15·2

The results of many tests of flat tarred ropes have given a mean strength of from 3·43 tons to 3·75 tons per square inch, rupture taking place at the points of attachment. The elongation rarely exceeds from 5 to 6 per cent.

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* Foreign Abstracts, Civil Engineers.

From all the results of testing, the average ultimate tensile strength of rope was as follows :—

White hemp	4·76 tons	to	5·08 tons	per	sq. in.
Tarred hemp	3·54	„	3·81	„	„
White manilla	4·44	„	4·76	„	„
White aloes	2·54	„	3·17	„	„
Flat ropes of tarred hemp or tarred manilla	3·54	„	3·81	„	„

The results of practice show that round ropes and cables may be worked, with but moderate attention, at a stress equal to one-third of the breaking stress, and flat ropes one-fourth. In ordinary industrial practice the proportion is often but from one-sixth to one-eighth.

Ropes made from esparto and cocoa fibres have an ultimate resistance of from 1 ton to 1¼ ton per square inch.

Wire ropes for mining service, of the first quality, have an ultimate strength of from 40 to 45 tons per square inch of metal section.

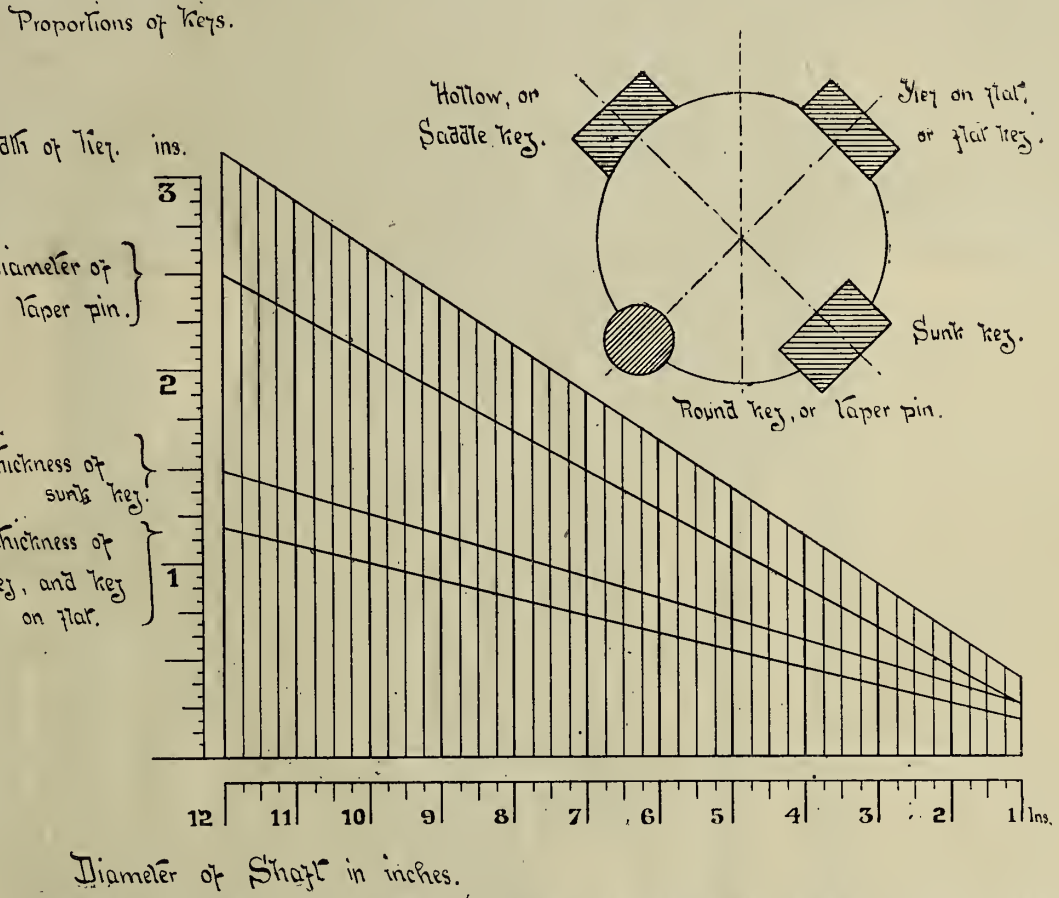
According to one system of testing wire, it is strained to one-tenth of its total resistance, and is exposed to the fall of a weight of 2 kilograms, or about 4½lb., from a height of from 5ft. to 6½ft. It withstands from eight to ten falls before rupture.

From the results of numerous experiments it is found that cast-steel wire ropes stretch from 4 to 6 per cent before rupture, with an elastic limit of from 2 to 3½ per cent. Such ropes bear three-fourths of the breaking stress before exhibiting any signs of failure. The author is of opinion that as iron has superseded hemp as the material of standing ropes, so iron will be superseded by steel.

PROPORTIONS OF KEYS.

The accompanying diagram gives, graphically, the dimensions of keys for shafts up to twelve inches diameter, of the four general classes, viz.—

1. The hollow, or saddle key, which is made hollow on the bottom to fit the shaft, and has a slight taper on the top, the sides being parallel. This description of key is only used when light strains have to be transmitted, for it depends on friction alone to resist any turning moment. It is used very extensively for keying ordinary pulleys to their shafts when some portion only of the power is to be taken from the shaft, and when well fitted gives very satisfactory results, and has the advantage of permitting the pulley to be shifted along the shaft and fixed in any position without the necessity of cutting fresh keyways. The thickness given on the diagram is the mean thickness, or half way along its length, and at the centre of its breadth; the taper, or drift, on the top should be about one-eighth of an inch per foot, or 1 in 96.



2. The flat key, or key on a flat. This class of key is made flat on all four sides, and a flat is filed on the shaft on which it rests, and is used for keying eccentrics on to their shafts, hand levers, and in cases where light strains have to be imparted in alternate directions. The top should be tapered slightly, the sides parallel, and the flat on the shaft a trifle broader than the key.

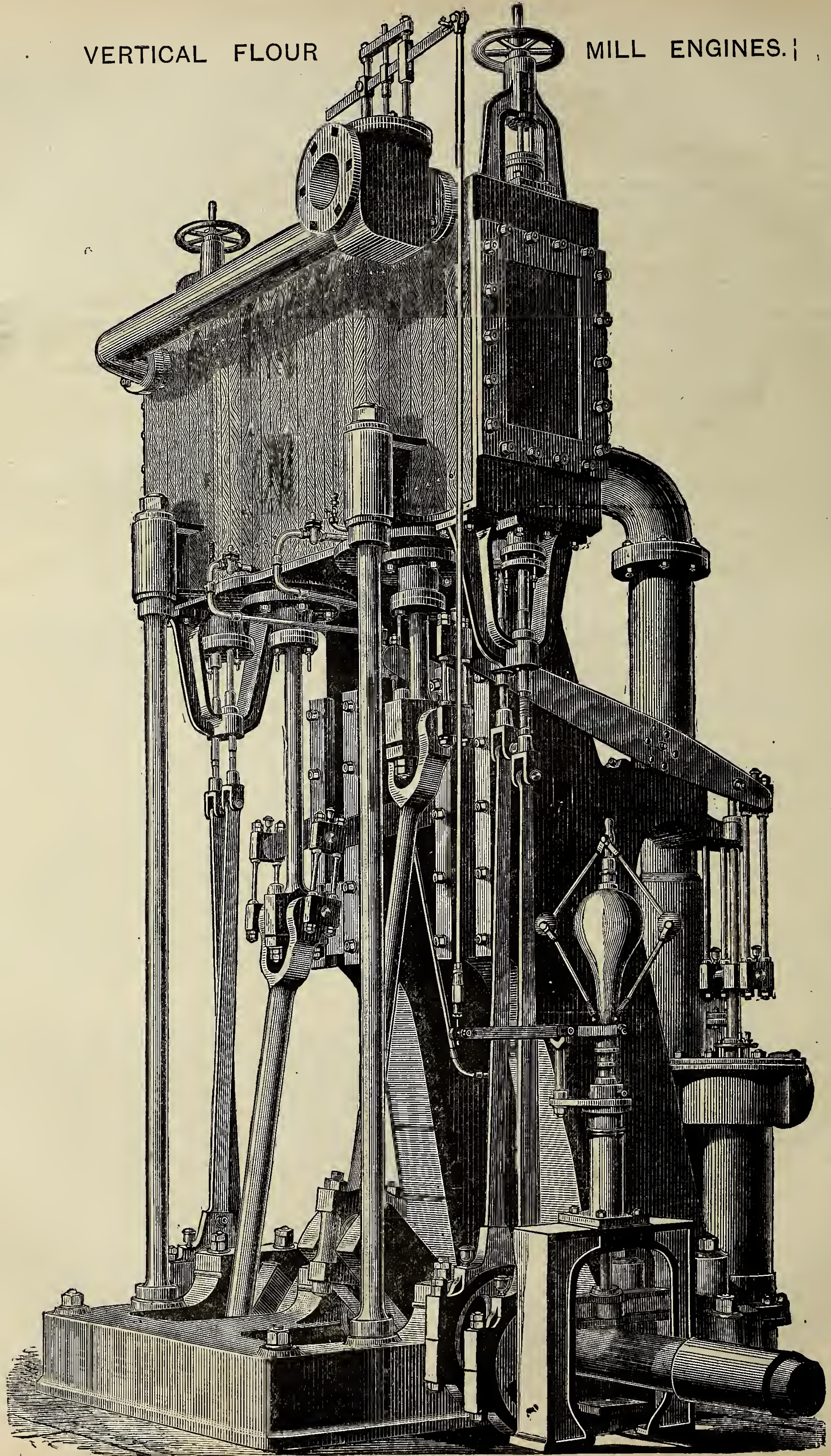
3. The sunk key. Keys of this class are flat on all sides, as in the flat key, but are sunk into the shaft to a depth equal to half the mean thickness of the key measured at the side. This method of fitting keys is always adopted for cranks or spur wheels when heavy strains have to be transmitted. In fitting such keys, a piece of wood is cut to size and driven in for use as a template in making the metal key, and it is very important in all systems of keying that the pulley or crank is a tight and good fit on the shaft, for if not the upper side of the key and the lower side of the shaft only will take a bearing, and the wheel will ride on these two opposite points, when, if subjected to any vibration, the key will soon slacken, and the whole become loose; also, it is best to drive the key home with a heavy hammer, on account of its giving a more penetrative blow than a light one. The proportions given on the diagram are for keys to transmit the whole power that can be taken from the shaft, but looking at the subject on its theoretical side, the key should be proportioned to the power to be taken off, so that for ordinary pulleys, when some power only is to be transmitted, the key should be smaller than in the case of a crank when the whole of the power has to be transmitted, but in practice it is usual to make all keys alike for the same diameter of shaft.

4. The round key, or taper pin, is generally only used in cases where the crank has been previously shrunk on to its shaft, and can only be used when the crank is at the end of the shaft. It is fitted half in the shaft and half in the boss.

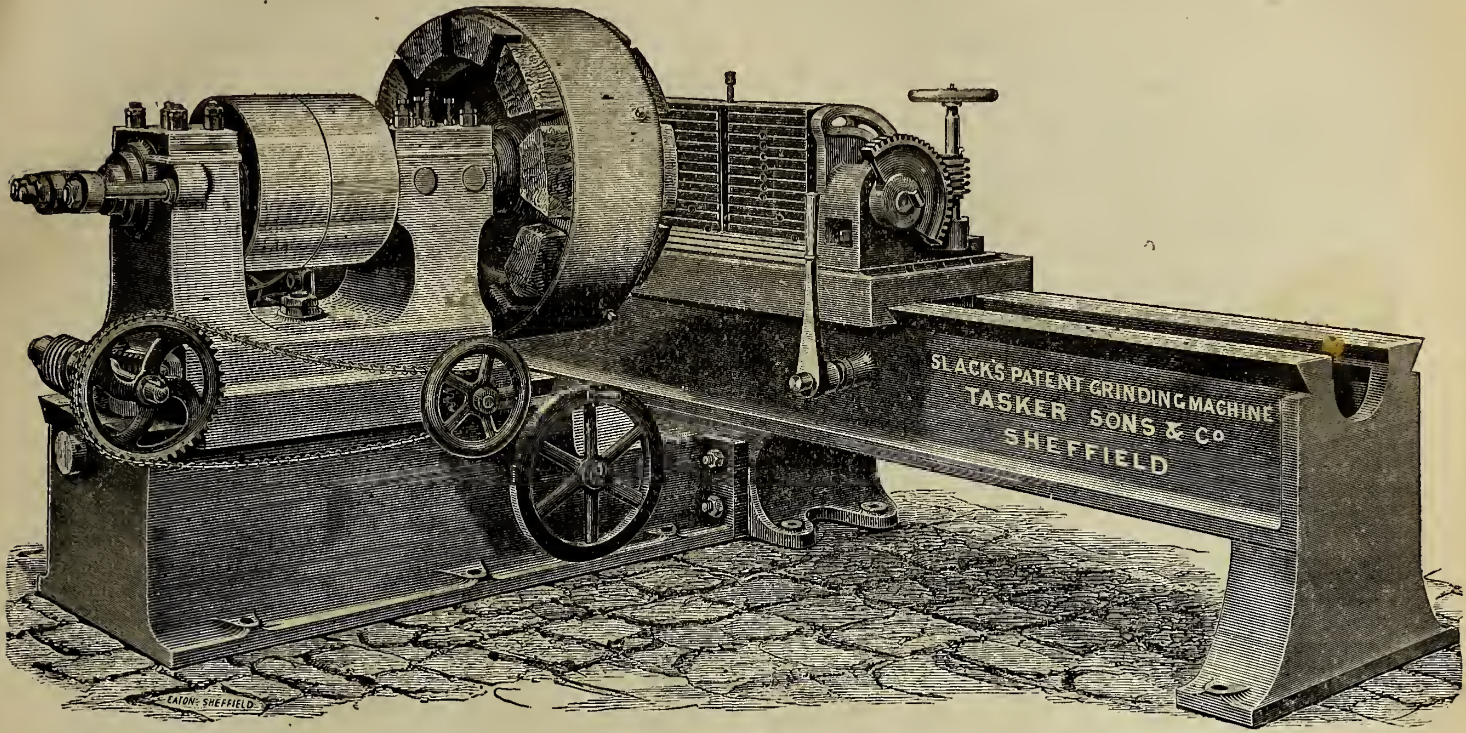
When a very secure hold is required at some intermediate position on a shaft two keys are sometimes fitted at right angles to one another, the one a sunk key and the other on a flat. By this means the shaft is held firmly at four isolated points.

To minimise the risk of splitting the boss in driving keys home, the edges should be slightly rounded.

VERTICAL FLOUR MILL ENGINES.



IMPROVED GRINDING MACHINE.



Messrs. Tasker, Sons, and Co. are introducing a new machine to the Sheffield trades that bids fair to cause a revolution in the operation of grinding.

For generations the Sheffield grinders have sat astride their "horsings," as the wooden frame upon which they sit is termed, in rear of the revolving stone, the horsing being secured firmly by strong chains to the frame in which the stone revolves. The precaution is quite necessary, as it not infrequently happens that the stone bursts, and pieces are sent flying in all directions with terrific force, and often fatal consequences.

Our illustration gives a very clear idea of how Mr. F. Tasker has surmounted most of the difficulties in the way of an improvement in the physical condition under which grinders work, by securing absolute immunity from burst stones, and enabling them to turn out six or eight times the quantity of work in a superior manner.

From the engraving it will be seen that the machine grinds by means of grit or emery segments, fixed in a revolving head, mounted upon a strong spindle, which runs in a massive headstock, the bearings of which are simply and easily adjusted. At right angles a strong bed stands, almost like that of an ordinary lathe, upon which the frame, carrying the work operated upon, slides in front of the revolving stones, thus insuring an almost perfectly true surface to the article under operation. The headstock can be advanced or withdrawn from the cross bed, to suit any thickness of material to be operated upon, and it will swivel either way, presenting a continual change of cutting surface, either convex or concave, and insures very rapid cutting power. It will grind hardened steel blades without in the slightest degree drawing the temper.

The machine will grind boiler plates, flange pipes, iron or steel castings, girder ends, wood planing machine irons, knives of all kinds, and, in fact, can be adapted to any kind of work where a true surface is required, at about one sixth the usual cost. The materials and workmanship are good, some parts of the machine being made of the well-known "Nordenfelt Mitis" castings. It may be mentioned that the ever-watchful German has already ordered some machines from Messrs. Tasker.

VERTICAL FLOUR MILL ENGINES.

CONSTRUCTED BY MESSRS. STEVENSON AND CO., CANAL FOUNDRY, PRESTON.

In a recent issue (see *Practical Engineer*, March 23rd) we drew attention to the advantages of the direct-acting vertical type of engine, and expressed our surprise that it had not become more popular on land. We have pleasure in illustrating herewith an engine of this kind, built for driving a flour mill, by Messrs. Stevenson and Co., Canal Foundry, Preston. The special type of engine shown in our engraving was designed to meet the requirements of a case where economy of floor space was an important matter, and the marine type was therefore adopted as being the most suitable for the purpose. The cylinders, which are both of the condensing type, owing to the fact that old boilers were already in position and only about 50lb. to 60lb. of steam available, are 18in. diameter, with a stroke of 3ft., and are bolted together in the middle, with the steam chests outside. The valves are of the ordinary slide description, with cut-off plates working on the back, and made adjustable in the usual manner. Each engine is fitted with an air pump of the usual single-acting kind, 10½in. bore, working at a stroke of 18in. The condenser, which is of the jet description, is placed on the engine bed between the two pumps. The pumps are worked from the engine crossheads by wrought-iron side levers, coupled to pump and engine crosshead by wrought-iron links of the marine pattern. The engine crossheads are forged solid with the piston rods, and fitted with wrought-iron caps and brasses and cast-iron shoes made adjustable for wear. The double-sweep crank shaft has three main bearings, 7in. diameter by 11in. long, and has a solid coupling end to connect mill shaft. The crank pins are also 7in. diameter. The engine bed is 12in. deep, and the cheeks are of box section. The cylinders are supported at the front by two wrought-iron polished pillars. A quick speed governor is driven from the crank shaft by bevel gearing, and regulates the speed of the engine by means of an ordinary throttle valve. The flywheel is 12ft. diameter, and weighs seven tons. The engines run at a speed of eighty revolutions per minute, and are remarkably steady and free from vibration.

Engineering Society, King's College, London.—At a general meeting, held on Tuesday, May 22nd, the president in the chair, a paper was read by Mr. Cochrane on harbours. Before dealing with harbours proper, the author gave some account of the forces against which harbours serve as a protection—*i.e.*, wind, waves, tides, currents, &c. Passing then to the harbours themselves, he divided them into two classes—(1) jetty harbours and (2) harbours protected by breakwaters, taking Calais, Aberdeen, and Dublin harbours as examples of the first class, and Portland, Cherbourg, and Holyhead for the second class. The various forms of breakwaters, such as (1) mound of rubble and concrete blocks, (2) mound with superstructure, (3) upright wall, were described, and the peculiar advantages attached to each. Examples were given of each case, and detailed descriptions accompanied by diagrams. A vote of thanks was then accorded to Mr. Cochrane for his paper, and the meeting adjourned.

AN ENGINEER'S LIFE AT SEA.—VII.

BY A SEA-GOING ENGINEER.

[*Continued from page 232.*]

Management of Boilers.

In the management of boilers at sea, a few hints may not be thrown away on the inexperienced. In the engine-room the water in the gauge glasses should be kept as nearly as possible at the same level in both boilers. It is usual to work at about half glass, but with priming boilers it must be kept as low as possible. The effect of a list must also be taken into account, so that no part of the combustion chamber crowns may be bared. Before leaving port, each engineer should, if possible, see for himself how much water there is over the crowns when at the bottom of the glass. He will thus be able to estimate more accurately the effect of list. He will soon find that the water rarely feeds itself regularly into the two boilers, but that he can save himself much trouble if he gets a methodical way of setting the feeds. One check valve should always be fully open, and the feed regulated with the other, keeping count in every case of the number of turns it is open or shut. Water seems always to flow to the boiler which has the more inefficient fireman. This excess of feed is, however, only apparent, and is due to the other fires evaporating more water, and thus causing its disappearance. Only by handicapping the better fireman with more feed can the water be kept at its normal level.

Before cleaning a fire, the water in that boiler is, for obvious reasons, always pumped well up during the preceding watch. When blowing down has also to be carried on, the cold water feed must be kept off as long as possible at the beginning of the watch which has cleaned a fire, and it must also be shut off towards the end of a watch when a fire is being burned down. The firemen readily know when an engineer is trying to help them by the manipulation of the feed, and when they see such to be the case they are encouraged to do their best.

All taps of water gauges must be tested occasionally, and the cap on top seen to be readily removable for the insertion of a glass. Neglect of this may lead to much unpleasantness, and perhaps risk; for if a glass breaks, especially in rough weather, it is no easy matter to run about getting spanners, which perhaps do not fit, in order to shut off the steam and water which is flying about in all directions. The engineer has also to look after the engines at the same time. A careful "second" will always satisfy himself that the spare glasses he has are of the proper size, for as the stores usually come aboard at the last moment, mistakes are sometimes made. He will also leave out several glasses with their rings, where the engineer on watch can readily get at them. Should the inexperienced find difficulty in keeping the joint of the new glass tight, it is probably because the rings are slightly too large. They must then be cut, and will make as tight a joint when cut as when whole. Should there be any trouble with the rings, lamp cotton loosely twisted and coiled round in the stuffing-box will make a joint that will take the ship to the next port. It may be as well to remind the tyro that in his hurry he must not forget to blow steam through the new glass before shutting the drain cock and turning on the water, otherwise the glass, suddenly heated and under pressure, may fly to pieces in his face. When on watch it is not necessary to be always trying the drain cocks, for this induces them to leak. As long as the water is seen to range freely up and down with the motion of the ship there is little fear of the taps being choked. Should the upper tap choke, as may happen in a priming boiler, the pressure will force the water to the top, and show a full glass. Should the bottom tap choke, the water will also rise, but more slowly, as the steam condenses in the glass; a leaky drain cock would, however, in this case prevent the glass from filling. In either case the water will cease to range up and down. Before and during the cleaning of tubes, the feed must be regulated as in cleaning fires, and the engines also are usually slowed down. The throttle must, however, be opened as soon as possible afterwards, or the firemen will not do their best. As the voyage progresses, and the water in the boilers approach their limit of saltness, as shown by the salinometer, the cold auxiliary feed has to be frequently on to take the place of the water blown out, and with this to contend against, as well as to clean their fires and tubes, the firemen's work gets harder. If the steamer is not large enough to carry coal trimmers, the coal also, by getting further back in the bunkers, makes it necessary for the engineer to study the firemen in every way he can, or his steam will suffer. When blowing down, open the sea cock first. This keeps the boiler pressure off the connecting pipe and joints, and also prevents the setting fast of the sea cock through expansion by heat. Also shut the boiler cock first. When blowing down, it is unsafe for an engineer to let anything else occupy his attention. He should stand watching the water gauge till it is time to stop. A light tap on the top of the shut cock is sometimes needed to ensure its tightness. If leaky, a cracking noise, due to condensation, will usually be heard, but it is as well to feel the pipe with the hand, say half an hour after blowing down; its being then cool proves the tightness of the cocks.

Should there be very low steam on any watch, the inexperienced must be careful how he undertakes to instruct the men. They may be experienced men, and his attempt on one set of fires may be followed by a fall of steam. It is possible that the fireman on the other boiler may purposely bring about this result, to humiliate the would-be instructor. With a good draught, and clean fires and tubes, bad steam may be due to a hole in the fire at the back, caused ignorantly or maliciously. With bars thus bared it is impossible to keep steam, though the cause can only be detected by running the rake over the fire. An ignorant fireman will use one stereotyped method of firing to every boiler, while an intelligent one studies the boilers to find their peculiarities. If the bars are close together, or the coal caking, he will fire lightly. If a strong draught rushes through the ventilating holes in the doors, he will make his fire thicker near the front. When the fire seems to burn out most at the sides of grate, he will have the coal thickest there, and hollowed down in the middle. As a general rule, however, the fire should be laid as evenly as possible all over.

When in the stokehold, it should be made an invariable rule never to walk under the ventilators. Ash buckets sometimes stick when being hoisted up, and the writer has been brushed by a falling bucket which broke the foot-plate he was standing on. When cleaning fires, see that the hot coals are clear of the boiler plates before water is thrown upon them, and in port see that damp ashes are not left against the boiler front, but drawn back from the plates, which, otherwise, they will corrode.

Bridges should be kept as high as the draught will allow. 8in. or 9in. from the furnace crown is a usual opening. Some keep the bridges low enough for a man to get over in port, but as they are easily removable, such a rule is useless. To check the rise of steam, some steamers have loose doors for the ashpits to be lifted on and off. This tends to overheat and bring down the bars by checking the radiation into the stokehold. For the same reason great variations of temperature occur in the ashpit, to the detriment of the furnace tube. A funnel damper gives probably the best results, and the fires are very sensitive to its action. By also acting on all the fires at once, there is a uniform lowering of temperature throughout the boilers, and less chance of a fire being deadened by damping. Should the damper be closed too much, there can be no mistake about it, for smoke and fire will immediately issue from the furnace doors. It will save much annoyance if the damper rod be fitted with a ferrule, so that the men cannot pull it down too far and cause this. Another method, that of opening fire doors, is perhaps the worst that can be used. It is much more injurious to the furnace plates than even the opening of smoke-box doors. The latter is the quickest way of checking draught. Sometimes it is unavoidable, as when an unexpected stop has to be made while under full steam; but many engineers regard it as causing serious injury. They say that it cools the tube plate and tubes, and causes the latter to leak. Anyone expressing doubts of this will perhaps be met by statements of alleged fact, manufactured at a moment's notice, to fit the theory. In many cases of such leakage it will be found that the tubes are either very old, or quite new, in which case they may not have settled down to their work. These will explain many cases, and among the remainder there may, perhaps, be found room enough for sensible men to differ. With smoke-box doors open, it is clear that cold air cannot actually enter the tubes, or the course of the draught would be reversed. The hot gases, though checked, are still passing through the tubes and over the tube plate, and act as a screen of hot gas which can be felt by the hand. Cold air can only pass through this by first mixing with it, and lowering its temperature, but while such mixing is going on the gases are rising to the funnel, while their place is being taken by fresh supplies of hot gas. The only apparent loss seems to be that due to radiation from the open smoke box, but there is probably less variation of temperature on the tube plate from this cause than there is in ordinary firing from the alternation of black and red coal on the bars, causing alternations of smoke and flame in the tubes.

Electric Welding.—The bicycle manufacturers in America are introducing the process of electric welding by the Thomson-Houston process into their works.

THE CONSTRUCTION OF THE TAY VIADUCT.

At the ordinary meeting of the Institution of Civil Engineers, on Tuesday, the 8th of May, the president, Mr. Bruce, being in the chair, a paper was read on "The Construction of the Tay Viaduct, Dundee," by Mr. Wm. Inglis, Assoc.M.Inst.C.E.

Referring to the difficult character of the work, the author stated that the bridge across the Tay was probably the longest in the world over water, and for a considerable distance operations had to be conducted at a point in the river which was navigable for vessels of considerable tonnage. Seventy-three of the eighty-five piers in the structure were cylindrical, in groups of two for each pier. The shafts, as sunk into the river bed, were formed primarily of wrought-iron cylinders, built in annular sections. The first section was provided with a cutting edge which sank into the river bed as the superincumbent weight was added. The cylinders were filled with concrete, which formed a compact shaft encircled by an iron tube. The sinking of the shafts was accomplished by means of platforms, composed of five water-tight tanks, two long lateral tanks being connected by three short ones, the intervening spaces being left open. Through the open spaces, or wells, the cylinders were sunk and filled with concrete, the distances being exactly measured, so that the centre of the well coincided with the centre of the shaft. Columns or legs were passed through apertures at the corners of the platform, their extremities resting on the river bed, and their shafts being fitted with pin holes, by which the height of the platform could be regulated. The appartus on each platform was an engine and boiler for actuating the hydraulic and other pumps, workshops for the repair of tools, two 10-ton cranes, one 3-ton crane, a concrete mixer, and a centrifugal pump. The stage was raised or lowered by hydraulic gear, consisting of a cylinder 12in. in diameter, piston, piston rod, open crosshead, and the necessary valves. When the platform was to be floated from one pier to another, it was lowered to catch the tide two hours before high water. Ropes were carried from one side of the stage to the piers of the old bridge, and to three heavy anchors on the other. The steam crane was used as a winch, and when the platform had been brought to its new position the legs were lowered down and fixed. The foundation cylinders were riveted together on shore, the various rings being lifted from cargo boats and placed in position by the 10-ton cranes. The first ring was formed of ⅜in. wrought-iron plates, 23ft. in diameter and 13ft. 4in. deep; above this was the taper, 7ft. deep, and then the upper portion, 18ft. 6in. in diameter. Each added ring was bolted through an internal flange to the preceding one, and these were lined with brickwork in the upper portion, and lowered to the bed of the river by hydraulic jacks. The excavation was accomplished for the most part by a steel digger of the Milroy pattern. This implement, however, was found ineffectual where silty sand had to be lifted, and another process was successfully attempted. Two flexible hose pipes, each 6in. in diameter and 20ft. in length, were placed in the bottom of the cylinder, the ends being brought together and joined into one 12in. pipe leading to the pump on the platform. A diver was then sent down, who manipulated the suction pipes, so that whilst the one threw up sand the other kept the pump free by drawing clean water only. As much as forty cubic yards had been pumped up in an hour, giving a subsidence of over 2ft. in the cylinder. The cylinders having reached the proper depth, and the interior having been cleaned out to the cutting edge, the concrete was then put in. When the concrete was level with the flange carrying the brickwork, the diver packed it carefully underneath. The same process was followed in filling the twin pier.

The superstructure of the piers consisted of two hollow octagonal pillars connected by a semicircular arch. Each pillar was temporarily erected at the works in Glasgow, partially riveted there, and the various parts marked for re-erection. The pillars were placed in position by using one of the movable platforms already described, from which all the apparatus had been removed, and a 5-ton steam derrick substituted. This was only necessary at the south side of the river, where the viaduct was highest, the gradient of the bridge at the north end permitting the use of boats with special derrick cranes instead of the platforms. The shallowness of the water on the sand-banks necessitated rapid working at the latter point, and the majority of this work at the north end was erected during portions of three tides, or a total of twelve working hours. The riveting was effected afterwards from a platform of light lattice girders, suspended on each side of the pier, which also served for use in painting the structure.

The lattice girder work of the old bridge formed part of the roadway of the new viaduct. The girders were removed from their old position by floating them upon two large iron pontoons, 80ft. by 27ft. 6in. by 8ft. deep, stiffened internally by lattice girders and water-tight bulkheads. These were bound together by girders, upon which lattice columns were erected, fitted with telescopic portions that could be adjusted to any required height. The pontoons were floated at low-water underneath the girders to be removed, and as the tide rose the telescopic girders were pushed up and securely pinned to the main column. At full-tide the girders were free from the old bed-plates and clearly afloat, and by manipulating mooring ropes the pontoon was drifted to the side of the new bridge, a distance of 60ft. On reaching its intended position, the hydraulic rams which had raised the girder from the old piers were opened, and the span was allowed to drop into its place on the new structure. The curve of the bridge at the north side of the river prevented this method from being adopted there, and the girders were transferred from the old to the new piers by means of travelling steam cranes. The new girders were built in the yards adjacent to the railway sidings on each side of the river, the riveting being done by hydraulic machinery. To bring the girders into position two travellers were constructed, by which each completed girder was transferred to the line of rails and carried to its position. The large spans were intended at first to have been erected from staging suspended between the piers, but it was ultimately decided to erect them on shore at the south side of the river, and to float them out to their positions. A timber jetty, 400ft. long by about 100ft. wide, was erected and provided with two docks capable of admitting pontoons, by which the girders might be floated. Temporary rails were laid, so that cranes might travel along the whole length of the girder while in process of erection. The bottom booms were first laid down and riveted; the struts, ties, and parapets were next dealt with; then the top booms were placed and riveted, and afterwards the top cross-bracings and wind-ties. When the girder was completed, the temporary flooring of the docks at each end of the jetty was lifted, and the pontoons were introduced. During the rising of the tide the pontoons were adjusted, and after the weight of the span, 514 tons, had been transferred to them, the girders were lashed round the pontoon stools. When free and afloat the pontoons were taken in tow by four steam-tugs, and towed down the river for some distance, so as to catch the flood-tide, which floated them to their positions between the piers. When placed at the spots which they were to occupy, the pontoons were partially sunk, so as to be free of the girder, and were towed back to the dock to repeat the operation. The large spans, being now ready at the base of the pillars, had to be raised to the level of the viaduct.

Underneath each end-post inverted hydraulic rams were bolted to the flanges of the bottom booms, and cross-girders were placed across the framework, and were secured to the columns so that the rams might thrust from them. The hydraulic power was so regulated that it could be applied to the ends of the girder alternately. In this manner the span was lifted at one end 15in. in two lifts, and the operation was repeated till the top of the pier was reached. The plates which had been removed from the superstructure of the piers to allow of the passage of the girder were fixed and riveted immediately after the span had been raised. The girders rested temporarily on the permanent cross-girders of the pier, thus enabling the lifting columns and bracings to be removed to another pier and erected for use. The bed-plates and rockers were inserted whilst the girders were thus temporarily raised about 6in. above the finished level of the bridge. The flooring, which had been left incomplete until the spans were in position, was then finished and left ready for asphalting and laying for the permanent way.

SNOW IN THE GOTHARD.

The engineer-in-chief of the Gothard Railway gives some interesting details of the fall of an avalanche during the past winter, which blocked up this line, and at the same time caused the death of five workmen. The catastrophe occurred on February 15, after a prolonged fall of snow, which covered the ground to a greater depth than in any winter since that of 1874-5. About three o'clock in the day an avalanche had fallen directly in front of the southern entrance to the covered way near Wasen, blocking it up, much of the snow being forced inside the gallery by the pressure of the wind. Six workmen were immediately sent from Wasen to clear the line, but they had been thus employed for not more than half an hour before a fresh avalanche rushed down, this time blocking up the northern entrance. This new avalanche was of colossal proportions, the like of which, it is stated, had not occurred within the experience of the oldest inhabitants in the district. Its fall caused a tremendous displacement of air, which, aided by the north wind, rushed up the gallery, throwing the six workmen to the ground, and forcing immense quantities of snow up the shed, which instantly covered the unfortunate men to a depth of several feet. The snow, it is stated, was forced up the gallery for a distance of 50ft., and was so compact that it was necessary to use pick-axes in removing it, while the *débris* from the avalanche extended nearly 350ft. further. Under these conditions there was but little hope of finding any of the workmen alive, but nevertheless the rescuing party succeeded in finding one of them still breathing, though the other five were all dead. The facts here set forth may appear extraordinary, but the mass of air displaced by an avalanche raises a perfect tornado, which is capable of demolishing the strongest buildings and of breaking off at their base trees upwards of 3ft. in diameter and transporting them considerable distances. It is stated that the increased severity of the avalanches in this district is due to the gradual deforesting of the hill slopes, previous to which they were few in number and of but little importance when they did occur.—*Engineering.*

CANAL BOATS DRAWN BY STEAM.

Last week, Sir Richard Moon, chairman of the London and North-Western Railway Company, and several of the directors, Mr. Webb, the chief engineer, Mr. Chambers (boat yard superintendent), and other officials, visited Worleston to watch some further experiments with locomotives on the towing path of the canal. A number of canal boats had been drawn up near where the length of rails had been laid, and upon which stood an 8 h.p. locomotive from the railway works. One canal boat was attached to the engine by a stout rope about thirty yards long. Other canal boats were placed behind at a distance from each other of several yards. Eight canal boats were thus attached to the engine, their aggregate weight being upwards of 140 tons, most of them being laden. A man was placed in each of the boats to steer it. The engine started with the eight boats, but it did not get along very satisfactorily, oscillating somewhat on account of the irregular motion. It, however, drew them along at about four miles an hour, which is about the speed at which the horses on the towing path travel. The engine having traversed the section of rails, a return was made with four boats, and the speed and motion were altogether satisfactory, the boats going through the water steadily and the engine working smoothly. Another experiment was then made with six boats, and this also appeared to be satisfactory. The length of the canal upon which the experiment was tried was the best that could be selected for the purpose. Should the result of the experiments justify it, the company will probably lay sets of rails alongside the canal from Chester to the Midlands. Great alterations would, however, be required at the bridges and locks and along portions of the canal.

A NEW METHOD OF SECURING CRANK PINS.

In a brief paper presented at the Nashville meeting of the American Society of Mechanical Engineers, Mr. C. C. Collins describes as follows a method used by him in setting crank pins :

Some time since, in making some experimental machinery, it was found desirable to use a crank shaft in which the crank pin could be changed, sometimes using 8in. throw and sometimes 12in. throw. That is, in a part of the experiment the piston, which was 14in. diameter and loaded to 250lb. to the square inch, would have a stroke of 24in. ; then it would be changed to 16in., these changes being made a number of times. It will be seen that with this pressure, whatever method of securing the crank pin might be adopted, it must be one which, when the pin was in place, must be practically unyielding and not liable to work loose; at the same time it should be one which would allow of easy removal of the pin without injury to either crank or pin. Taper holes were bored in the crank, largest at the back side. A bush was also bored taper, and turned on the outside to fit the taper hole in the crank, so as to bring the edge to within about $\frac{3}{32}$in. of the front face of the crank. In fitting this bush, the taper hole in the crank was scraped so as to insure the absolute truth of crank pin in relation to the shaft. The pin was then turned and fitted to the bush so that the shoulder should be at the same distance from the edge of the bush that the face of the crank was, viz., $\frac{3}{32}$in. ; this bush was then cut from end to end, so as to give it a chance to expand or contract, and it thus became a circular wedge between the crank and the pin. The end of the crank pin is fitted into the nut, care being taken that the thread is a good fit. It is better not to make pitch of the thread too coarse. Now insert the pin and place the circular wedge in at the back between the pin and crank, and force it well home by means of the nut, and you have a pin as rigid as if it had been put in by means of shrinking, or forced in by hydraulic pressure, and yet one easily removed without injury either to pin or crank. This particular pin was never subject to a continuous test in running, but it showed, under a variety of trials, that it would stand up to its work without fault.

NEW SWEDISH RIFLE.

A new rifle was lately tried at the military school at Rosenberg, Sweden, where experiments have been going on for a series of years with a view of producing a thoroughly efficient rifle for the Swedish army. There have been several royal commissions engaged in this important matter, each generally upsetting the verdict of its predecessor, so that the Jarmann repeater (a Norwegian model) with 10·15 millimetres calibre, which found favour with the commission of 1880, was entirely discarded by the one of 1884, the repeater type being found unsatisfactory. The last year's experiments have consequently been conducted with the view of producing a rifle of modern calibre, but at the same time retaining the Remington breech action, which might ultimately be exchanged for a thoroughly practical and efficient repeater mechanism. During last summer there were made a series of trials with 30 rifles and 50 carbines of a model called the "1874-1887 rifle." These trials have been brought to a close, and the result is looked upon as extremely satisfactory. The new rifle, which has the exceptionally small calibre of 7·5 millimetres, and which, it must be borne in mind, is no repeater, has proved itself to surpass the Jarmann repeater in quickness of firing. Besides, the percentage of hits with the new rifle, which is considerably lighter, has been better, and the recoil is very slight indeed. The loading movements also are not nearly so tiring as with the repeater, the movements being very short and convenient. Finally, the new rifle is also said to possess the advantage of cheapness.—*Engineering.*

CAULKING.

Caulking is something that is not always done as it should be. In fact, in some sections of the country it is done as it *shouldn't* be, about as emphatically as it is possible to do anything. The thing most particularly referred to in this connection, and the practice of which should bankrupt any boiler-maker, is known as "split caulking." To do caulking in the best manner, and as it should be done, the edges of the plates should be planed. They are planed in all first-class shops, and trouble caused by bad caulking is something very rare with such work. But of course this refers to new work. Repair jobs, and boiler work turned out of the shops in remote sections of the country where planers are unknown, afford the demon of split caulking a chance to get in his most effective work. He rarely neglects a chance that is offered him. Some one may inquire, what is split caulking ? To which we would reply, split caulking consists in driving a thin caulking tool, scarcely one-sixteenth of an inch thick, against the edge of a sheet so that a thin section of the plate is driven in between the two plates, with the idea of making a joint tight. The result generally is that the plates are separated from the edge of the lap back to the line of rivets, sometimes as much as one thirty-second of an inch, the only bearing surface outside of the rivets being the portion split off from the plate and driven in by the caulking tool. This bearing surface *may* be an eight of an inch wide, but it is apt to be much less, and no patent medicine yet discovered will keep the seam tight for any length of time. When a boiler thus caulked gets to leaking so badly that it can't be run, the boiler-maker is sent for, and he usually proceeds to do more split caulking, and in a short time the boiler leakes worse than ever. In one instance one of our inspectors examined a boiler and found one of the girth seams leaking badly. It had repeatedly been caulked in the above manner ; so many times, in fact, had the process been repeated, that there was not enough of the lap left to perform another operation on. He therefore gave instructions for putting on a patch, with a special caution to the owner, to whom he explained the cause of the trouble, to allow no split caulking to be done on it. On his next visit he examined the patch, and he declares that the boiler-maker had put in on it the worst job of split caulking he ever saw in his life.—*The Locomotive.*

CORRESPONDENCE.

We do not hold ourselves responsible for the opinions of our Correspondents.

PROPOSED ENGINEERING ASSOCIATION.

To the Editor of "The Practical Engineer."

Sir,—Will you allow me to ask Mr. J. Booth, through your valuable paper, if he will furnish us with more particulars respecting the Engineering Association. I should like to know what qualifications a person will have to possess to become a member of this association.—Yours, &c., Steam.

Stockport, May 22.

THE STEAM ENGINES AND BOILERS BILL.

To the Editor of "The Practical Engineer."

Sir,—"One of the Heroes" thinks if I had my way I should annihilate him. I would do no such thing, but merely commit the outrageous act of compelling everyone in charge of engines and boilers to hold certificates of competency, and leave inspectors and insurance companies with their good or bad qualities. The case that I stated is one that came to my notice recently, and not the only one by many. I gave it to show that inspection had its misgivings, and that we required competent men in charge as well as reliable men for inspectors. Perhaps "One of the Heroes" is of a nervous temperament, and thinks it something horrible to be held solely responsible for the safe working of a few boilers, but in my opinion there are far worse callings. How about two inspectors examining one boiler? Who is to decide when inspectors differ? Here is a case. A firm having two boilers, the owner wishes to increase the pressure 5lb. He writes to the company in which they are insured, and the inspector is one and a half hours examining two boilers, and the result is the company accepts them at the increased pressure. But the man in charge refuses to work them at the higher pressure. The owner then decides to have them examined by a separate company, one of whose inspectors expends eight hours in examination, and in the report which is received the boilers are refused at the ordinary working pressure, and these boilers were then removed. The cases I have mentioned are genuine, and sufficient has been said to judge of them without further particulars.—Yours, &c., Ignorance.

May 28th, 1888.

COMPOUND LOCOMOTIVES.

To the Editor of "The Practical Engineer."

Sir,—The contributor of the paper on Worsdell's Compound Locomotives congratulates me upon being a brother convert, and I reciprocate. There is a statement, however, that appears to be wrong, and which he corrects, regarding this particular system of compounds, viz., that these engines are unable to start unless steam is admitted to the low-pressure cylinder. If this statement has in any way misled the readers of *The Practical Engineer*, I am sorry for the same, but the contributor on Worsdell's has made it perfectly plain that these engines are quite able to start without the necessity of admitting steam to the low-pressure cylinder, except when on either of the dead centres (h.p. cyl.); and as this can occur at two points in one revolution, readers may judge how far the statement is wrong. I may say I am not in any way well acquainted with Worsdell's system, but the above defect, if it can be so called, suggested itself to me at the outset. Another and more important point, however, I think, is the difference in the turning efforts made by each cylinder when the gear is notched up for intermediate expansion.

As to coupling rods, I am still of opinion that their absence is of some benefit, as I consider that they are the source of that spasmodic hop-step-and-jump motion that can be felt when on the foot-plate. The metal of the tyres cannot always be depended upon to wear equally on each of the wheels of an engine, and, be they ever so carefully turned, sooner or later there will be found a perceptible difference in their diameters. Whether running on a straight or a curve, the evil is present; and it will be noticed, in the case of a single engine at least, that while one curve tends to aggravate this, a reverse curve will, in a manner, almost correct it, while a coupled engine admits of no such correction. We will suppose a case of a four-coupled engine in which the left wheel on the driving axle and the right wheel on the trailing axle are both slightly larger than the wheels on the other and opposite sides respectively. The right trailing wheel, while being larger than its neighbour on the same axle, is slightly smaller than the left driving wheel. On moving along a "straight," the right wheel on the driving axle, being the smaller of the two, will be skidded along the rail to the extent of the difference in the circumference of the driving wheels, and this continues through every revolution. This dragging, in the first place, tends to increase the discrepancy in the diameters. Further, the larger or right trailing wheel will be skidded along the rail to the extent of the difference in the circumferences of itself and the left driving wheel; and as the opposite trailing wheel is still smaller, it will also be skidded along the rail to the same extent, plus the difference in the circumferences of the trailing wheels. This, I think, will show the advantage of independent drivers. If the larger of the two trailing wheels had also been larger than both driving wheels, the same would happen, only it would be according to the state of that particular part of the road and distribution of the adhesion weight, whether it would be the trailing or driving wheel that would skid in this instance. On curves much the same thing happens, any corrections that might take place being prevented by the coupling rods and strains, causing much friction, that would have no existence only for coupling rods.—I am, yours, &c., Dreadnought.

May 29th, 1888.

QUERIES AND REPLIES.

Expansion Gear.—Who are the makers, and where can I get a descrip- of, Proell's automatic expansion gear?—Learner.

Answer.—Mcssrs. Robey, of Lincoln, are, I believe, the English agents for the "Procll" expansion gear. A letter addressed to them would probably clicit some information regarding the same.—Omicron.

Tempering Snaps.—Which is the best method of tempering snaps for ⅞in. and 1in. rivets?—Blacksmith.

Copper Boiler.—Could any reader inform me what would be the most suitable kind of copper boiler, with fire box, for 2½in. by 3½in. stroke horizontal engine, to be heated by a lamp or otherwise, and what would the dimensions be?—F. W. T.

Concave Circular Saw.—Can any reader describe the use of a concave circular saw? It is supposed to be attached to tho end of saw spindle outside of bench and driving pulleys.—H. C.

Humidifyers.—Will some of your readers who have practical experience with the working of "Humidifyers" in weaving sheds kindly inform me as to their effectiveness? also give maker's name and approximate cost.—D. W.

Ejector Condenser.—Can any practical reader give me any information about Morton's ejector condenser, and say if the same could be applied with advantage to a 20 h.p. portable engine, there being a plentiful supply of water just at hand, but a long way to be always hauling coal? I do repairs at a saw mill engine in the country, and thought something like the above would save much coal in twelve months. I should also like to know the probable cost and rule as to size of injection pipes.—Young Fitter.

Machine for Stamping Nails.—Will one of your readers give me the name of a good firm to manufacture a special press for stamping out nails?—F. C.

Thin Plates.—Can any of the readers of your practical and valuable paper inform me if it is possible to get thin sheets of iron or steel (say 20's gauge) as large as 8ft. 6in. by 4ft. 6in.? If so, where?—Chalkline.

Ewart's Chain.—I should like to know the address of the firm who make a chain called "Ewart's chain," which comes to pieces, and to which additional links can be added from time to time.—F. P. C.

Composition for Driving Ropes.—Will some reader of *The Practical Engineer* inform me what is the best material to put on cotton ropes to keep them from wearing or to polish up the grooves. The pulleys have been turned.—J. H.

TO CORRESPONDENTS.

J. M. J.—Your best plan is to get the thickness from such a table as that given in "Templeton's Workshop Companion," and in similar books. For the second part of your question we would suggest a cylinder 9in dia. and 10in. to 12in. stroke. A vertical boiler standing 8ft. high would supply ample steam for this engine.

Invoice.—The Government charges on all patents are the same whether the article be large or small. In the case of a complicated machine the initial charges of the patent agent, if one is employed, will of course be higher, owing to the greater amount of care and time necessary in preparing the specification. See our advertisement columns for charges that we make for this work.

Removing Scale in Marine Boilers.—In answer to "Marine Engineer," we are not aware of any special mechanical contrivance for removing the scale from the smoke tubes of marine boilers. If it consists mainly of salt crystals, as you say, then more frequent blowing out would be advantageous to prevent the water from getting so densely saturated. The composition known as "Litholine" has a good reputation as a disincrustant, and you might give it a trial. The majority of boiler compositions now sold are cheap and nasty, and should be guarded against.

A. D. B.—We cannot say precisely what increase above the blowing-off point would be possible. It would depend on a number of circumstances, such as the grate area, intensity of firing, construction of valve, &c., &c. The discharging capacity of the valves, however, could not exceed that of two 2in. circles, and a circle about 2¾in. diameter would afford an equivalent area, but an open-ended pipe of less diameter than this would no doubt discharge quite as much as the two valves combined. A direct-acting valve loaded with a spring or dead weight is less liable to be overloaded or tampered with than those you describe. Thanks for the suggestion in the latter portion of your letter, with regard to which we may communicate with you further.

MISCELLANEA.

Large Bronze Statue.—A colossal bronze statue, measuring 17ft. high, of Sir William Wallace, is to be unveiled by the Marquis of Lorne at Aberdeen, on June 21.

The Liverpool Exhibition.—The Council of the Liverpool Exhibition have been compelled to proceed in the County Court against many of the persons who gave their names to the guarantee fund. Some of the cases came before the judge on Monday, and orders were made for payment by instalments, the lowest order being made for £2 a month.

Pipe Threading Machinery.—Messrs. D. Saunders and Sons, Yonkers, New York, have issued an illustrated catalogue and price list of tools manufactured by them, for working and manufacturing wrought-iron pipes. The catalogue is very complete, and excellently got up.

Forest Tramways.—The Madras Government is about to introduce the system of portable forest tramways at once into the forests of South Coimbatore, and is obtaining, through the Secretary of State for India, enough material to lay down seven miles of tramway as a beginning.

A Curious Dynamo.—A dynamo, which, whatever its other merits, takes first rank as a mechanical curiosity, has been invented by Mr. R. Mather, of Windsor, Connecticut. In this the engine driving the dynamo is placed inside the armature, of which it forms an integral part.

Amalgamated Engineers.—Mr. Charles Hough, chairman of the men's joint committee in the recent Bolton strike, Mr. Richard Barlow, secretary, and Mr. J. Thornton, a committee man, after having been expelled from the Society for the action they took in the strike, have been reinstated again; but, as a mark of displeasure, fines have been imposed.

Paris Exhibition of 1889.—Messrs. Davey, Paxman, and Sons, of Colchester, have contracted to supply the motive power in the British Section of the Paris Exhibition of 1889. The contract has been made, with the approval of the committee of the section, direct with the French executive, who undertake to supply motive power gratis to all exhibitors.

Defences of the Thames.—The defences at the entrance to the river Thames are to be strengthened shortly by a new gun battery, which the Admiralty propose to construct at Sheerness for seamen and Royal Marines stationed at the Royal Naval Barracks to practise from. The battery, which is estimated to cost £2,000, is to be equipped with the newest types of breech-loading and quick-firing guns.

Association of Chambers of Commerce of the United Kingdom.—A conference of representatives of the Chambers of Commerce in this Association will be held at the room of the Society of Arts, London, next Thursday, to discuss the Railway and Canal Traffic Bill, including Sir B. Samuelson's Bill on the same subject, the Technical Education Bill, and the Employers' Liability for Injuries to Workmen Bill.

The Goldfields of Southern India.—The gold-bearing rocks of India seem to be, on an average, far richer than those of Australia or America, but gross mismanagement, ignorance, and criminal extravagance ruined the credit of the Indian enterprise in its early days, and Sir Roper Lethbridge recently expressed his conviction that, with honest work and good management, a period of great prosperity awaited the goldfields of Southern India.

Messrs. Bolckow, Vaughan, and Co.—Mr. E. Windsor Richards, manager of the great industrial concern of Bolckow, Vaughan, and Co., Middlesbrough, has resigned his position, he having accepted the responsible post of managing director to the Low Moor Iron Works, near Bradford; and it has now been settled by the directors of Bolckow, Vaughan, and Co. that Mr. Franklin Hilton, who has been chief engineer and assistant general manager of their works for the past eight years, and resident near the Eston Steelworks, is to take Mr. Richards' place.

Reduction of Staff.—Owing to the reduction of the staff in the boilermaking department of Sheerness Dockyard, instructions have been issued by the Admiralty for the appointment of foreman of boilermakers to be abolished. The salary attached to the post (which has been rendered vacant by the retirement of Mr. Joseph Peters) is £300 per annum. The Admiralty have also ordered a party of riggers in the staff captain's department to be discharged, as, owing to the alterations in the rig of ships at present building for the Royal Navy, sufficient employment cannot be found for the existing staff.

Speed of Russian Trains.—It is proposed to increase the average rate of speed of mail trains in Russia from 20 miles an hour, including stoppages, to 23 miles per hour, and the Ministry of Railways is at present engaged in considering this weighty question. When we state that on some Russian lines the average rate of speed is 10 and 12 miles per hour, while an ordinary passenger train on the line between St. Petersburg and Moscow only travels at the rate of 15 miles an hour, it will be understood that the reform proposed assumes important dimensions. The fastest train in Russia is the courier train between St. Petersburg and Moscow, which travels, including stoppages, at about 28 miles an hour. This carries no mails, and consists only of a few first-class carriages.

Correction: In the article on Nominal Horse-Power in our issue of May 25th the following correction is necessary: Page 244, last line but one in the first column—"The rule proposed by him is as follows," should read, "The rule proposed by *them* (Lloyd's Committee) is as follows."

SELECTED PATENTS.

APPLICATIONS FOR LETTERS PATENT.

May 18th.

7361 Distributing Air for Ventilating Purposes, R. Lofthouse, London.—[Complete Specification.]
7370 Metallic Packing for Pistons, A. Oldham, Manchester.
7371 Drilling Machines, L. Litchfield, Nottingham.
7374 Motor Engines, J. Heaton and G. H. Holden, Manchester.
7377 Power Looms, W. L. Wise, London. (F. Martini and Company, Switzerland.)
7386 Gas Lamps, J. W. Körber and W. Steuth, London.—[Complete Specification.]
7392 Steam Engine Lubricators, G. Downing, Middlesex. (J. Mense, France.)
7394 Direct-acting Pumps, E. Lund, jun., London.—[Complete Specification.]
7402 Engines, M. P. W. Boulton, London.

May 19th.

7421 Railway Carriage Doors, W. Panter, Surrey.
7423 Stop Valves for Steam, W. H. Shaw and F. Shaw, Halifax.
7430 Jacquard Machines, J. Wilkinson and T. Wilkinson, of the firm of Wilkinson Bros., Yorkshire.
7433 Safety Lever for Vehicles, — Wilson and — Hull, Northampton.
7439 Water Motors, F. Bosshardt, London. (A. Delon, France.)
7443 Steam Engines, R. T. Terrers, London.
7447 Padlocks, J. Minors, D. Minors, and A. Minors, trading as J. Minors and Sons, and E. Raybone, London.—[Complete Specification.]
7449 Locks, W. P. Wenham and Wenham and Waters (Limited), Middlesex.
7455 Double-acting Presses, A. J. Boult, Middlesex. (C. Roux, France.)
7459 Testing Machines, J. H. Wicksteed, Middlesex.
7462 Tools for Cutting Boiler Tubes, J. Chambers, London.
7467 Engines Worked by Vapour, A. F. Yarrow, London.
6469 Gas Heaters, I. Spielmann, London.
7473 Interlocking Levers for Operating Railway Points, G. Edwards, London.
7474 Printing Machines, J. Jordan and E. Howard, London.
7479 Insulation in Electrical Machinery, F. L. Rawson and W. White, London.
7481 Refrigerators, E. Willows, London.
7484 Propelling Bicycles, R. Bland, Hull.

May 22nd.

7487 Electric Switches, G. Binswanger and H. J. Coates, London.
7490 Twist Drill Grinding Machines, I. Engelson, Jersey.
7493 Machines for Printing, J. Knowles, Manchester.
7495 Hydraulic Engines, T. Gallon and J. Chapman, Midlothian.
7500 Automatic Vacuum Brakes, E. H. Birley and [illegible]. H. White, Manchester.
7519 Safety Fluid Battery, E. G. Kempe, London.
7521 Hydro-carbon Motors, C. T. Wordsworth, London.
7522 Dynamo Apparatus, E. J. Houghton, London.
7523 Electric Lighting, E. J. Houghton, London.
7524 Lubricant, W. P. Kelly, London.
7526 Screw Propeller, H. C. Payne and A. W. Burstow, London.
7530 Electric Safety Lamp, E. R. Chittenden and E. E. Vaughton, Surrey.
7533 Purification of Water, H. E. Newton, Middlesex. (A. R. Leeds, United States.)—[Complete Specification.]
7536 Galvanic Batteries, B. Willcox, London. (T. P. Whittier, United States.)—[Complete Specification.]
7541 Electric Machines, W. P. Thompson, Liverpool. (H. W. Spang, United States.)—[Complete Specification.]
7542 Carriage Trucks, A. J. Boult, Middlesex. (W. Youmans, United States.)—[Complete Specification.]
7544 Locking Apparatus for Carriage Doors of a Railway Train, J. Kendall and O. Cooper, London.—[Complete Specification.]
7546 Oil Lamps, A. H. Hearington, London.
7547 Motor Engines, T. Browett and H. Lindley, London.
7554 Steam Engines, J. A. Arthur and T. C. Garfield, London.—[Complete Specification.]
7555 Vacuum Drying Apparatus, E. Passburg, London.—[Complete Specification.]
7557 File-cutting Machines, R. Haddan, London. (F. Neswadba, Austria.)

May 23rd.

7561 Disc Tap, J. Robbins and W. G. Creed, London.
7565 Type-writing Machines, A. Munroe, London.
7566 Supplying Feed Water to Steam Boilers, J. Tennent, Liverpool.
7567 Fire-bars for Steam Boilers, R. A. Ray, Lincolnshire.
7575 Carding Engines, W. Barker, Manchester.—[Complete Specification.]
7576 Self-making Joint, W. S. Shreeve, Warwickshire.
7577 Bicycles and Tricycles, J. Parker, Hull.
7579 Pumping Water, W. Baker and T. Le-Masurier, Upper Tooting.
7587 Preventing Boiler Scale, A. D. Birkovits and G. Koszegi, London.—[Complete Specification.]
7593 Sewing Machines, W. R. Goodbody, Liverpool. (Partly communicated by A. M. Barber, United Stated.)
7594 Ventilating or Warming Apartments, G. H. Eland, Liverpool
7597 Producing Motive Power in Engines, J. Wrigley, Liverpool.
7598 Machine Guns, T. Nordenfelt, London.
7600 Facilitate Locomotion in Fluids, C. Carroll, London.
7606 Valvular Arrangements of Fluid Pressure Engines, J. Craven and G. Sellers, London.

May 24th.

7613 Self-extinguishing Lamp, J. McDonald, Perth. (P. J. F. Grœme, Canada.)
7614 Water Motors, C. Krause and R. Collin, Germany.
7615 Couplings for Railway Rails, F. Biddiscombe and F. Hilton, Manchester. [Complete Specification.]
7617 Couplings, J. Bardsley, Oldham.—[Complete Specification.]
7619 Electric Battery, G. J. Weir, Glasgow.
7621 Pressing Machines, J. Templeman, Glasgow.
7627 Engine Indicators, T. S. McInnes, Glasgow.
7628 Automatic Brake for Wheels of Perambulators, W. Patterson, Newcastle-upon-Tyne.
7633 Steam Generators, G. H. Taylor, London.
7644 Rotary Engine, J. A. Wade and J. Cherry, London.
7645 Incubators, T. H. Delve, London.
7653 Stoppage of Locomotives, T. Volker and H. Nyland, London.

PUBLISHERS' ANNOUNCEMENTS.

BACK NUMBERS of "The Practical Engineer," from the commencement, can be obtained at either of our offices in London or Manchester, or by order of any Newsagent.

Vol. I. (bound), containing Nos. 1 to 44 inclusive, from March to December, 1887, price 6s. 6d., can still be obtained by order from any Newsagent, or will be forwarded, carriage paid, from either of our offices on receipt of the amount by postal order or stamps.

Numerous complaints having been made to us by Subscribers of the difficulty they experience in obtaining copies of the *Practical Engineer* in certain districts, we have to state that the Journal can be obtained by any Newsagent through the ordinary trade channels, and no difficulty should therefore exist in obtaining copies by order of any Newsagent.

For the information of the trade, we may state that copies can be obtained from either of our Offices in London or Manchester, or from any of the following wholesale houses.

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EDITORIAL NOTICES.

All communications for the Editor of this Journal should be addressed to 6, Victoria Station Approach, Manchester.

Communications intended for insertion in the current week's issue should reach us not later than Tuesday Evening.

We cannot undertake to return rejected manuscripts or drawings unless accompanied by a stamped and directed envelope.

Contributors are requested to write on one side only of the paper. Sketches should be sent on separate sheets.

TO ADVERTISERS.

Advertisements intended for insertion in the current issue should reach us on Wednesday morning at the latest.

THE
PRACTICAL ENGINEER.
JUNE 8TH, 1888.

THE PROPOSED BOILER REGISTRY AND INSPECTION BILL.

It has been generally expected that the above bill, which was introduced by Lord Stanley of Preston, and passed the second reading in the House of Lords last session, would be again submitted during the present session, and a select committee moved for to inquire into the whole question. Since that time, however, Lord Stanley has been appointed Governor-General of Canada, and his successor at the Board of Trade not apparently sharing the views of the late President, it seems more than probable that no further attempts will be made at present to legislate in this direction. Referring to the severance of his connection with the Board of Trade, Lord Stanley, in a letter to Mr. Thomas Gray, Assistant-Secretary, Marine Department, states that "he is afraid the Select Committee on the Boiler Bill in the House of Lords cannot now be moved for," and he requests Mr. Gray to place the case for the bill before the public, in order that it may be known "how great is the need for legislation." In accordance with this request, a blue book of thirty-eight pages has been issued, entitled "Memoranda prepared for the consideration of the Right Honourable the President of the Board of Trade," in which Mr. Gray recounts the steps which preceded and led to the enactment of the Boiler Explosions Act, 1882, gives a few groups of selected cases in which inquiries have been held, refers to the question of certifying boiler attendants, the laws of foreign countries on the subject of boiler inspection, and lastly explains the action which has led up to the preparation of Lord Stanley's Boiler Registry and Inspection Bill, and the lines upon which it is drawn in its present shape.

These "Memoranda" will be perused with interest by steam users and others interested in boiler legislation; but what will most strike everyone familiar with the constitution and working of the different companies and associations by whom boiler inspection is at present chiefly carried on in this country will be the unfair, not to say misleading, character of some of the statements which are put forward to support the case for the bill. In a recent article on the "Compulsory Inspection of Boilers" (*Practical Engineer*, May 4th, 1888) we stated that it was no secret that for a long time past some of the officials of the Manchester Steam Users' Association had been making strenuous efforts to influence members of Parliament, and to induce Government to legislate upon this question, with a view to compelling all steam users to have their boilers periodically inspected; and the "Memoranda" in question fully bears out this statement.

Notwithstanding the undoubted fact that the annual number of explosions has enormously diminished since the Act of 1882 came into force, it is stated in the Memoranda that the bill proceeds on the assumption "that there is necessity for legislation for what is believed to be a great and growing evil," and in support of this some damaging, and, if it had been true, damning evidence respecting some boiler insurance companies given by Sir William Fairbairn, the then President of the Manchester Steam Users' Association, before the Select Committee appointed by the House of Commons in 1870 and 1871, is quoted. Sir William Fairbairn at the time probably believed his evidence to be true, but it was afterwards shown to be incorrect and misleading in a very material particular, and we cannot but think that in the assumption made, Mr. Gray has been very much misled by the false data which have been laid before him. Speaking of the difference between the association of which he was president and the boiler insurance companies, Sir William stated that, "judging from the number of efficient inspectors employed by the first and largest company in Manchester, where more than 10,000 boilers are enrolled, the number of inspectors are probably in the ratio of one to about 1,000 boilers. We have about 2,000 boilers, and seven inspectors. I think the insurance company, which was the first company that was formed, has upwards of 10,000 boilers; and it is a question with me whether they have any more inspectors than we have for the 2,000 boilers."

The expression "It is a question with me whether," &c., should be carefully noted, as he does not state it as a fact, nor say positively whether he does or does not know the number to be the same as theirs; but on this uncertain question Sir William went on to make the following severe and sweeping observations, which are quoted by Mr. Gray in support of his "case": "From this it will be noticed that thorough inspection is out of the question, and so long as the practice of making money at the expense of human life remains prevalent, we shall never, in my opinion, be relieved from boiler explosions." Mr. Gray refers to this in his Memoranda as "very plain language," and remarks, in reference to what he terms the "then existing *quasi* inspection societies," that "whether that language is applicable to them now will be a fair subject for inquiry."

The above remarks at that time could only apply to the Boiler Insurance and Steam Power Company, of which Mr. R. B. Longridge was the chief engineer, and accordingly, in his annual report for 1870, published in 1871, Mr. Longridge refers to Sir William Fairbairn's evidence as follows:—

"In the above evidence there are two or three inaccuracies to which it is well to draw attention. The witness stated: 'There has not been a single life lost from the explosion of a boiler in charge of the association.' This would be true if it referred only to the boilers under their inspection since the year 1865, when the association adopted the insurance principle; but it is not true if it refers to the whole period that the association has been in existence, as, in the course of ten years, six of the boilers under their inspection exploded, causing the death of nine persons."

"In referring to the Boiler Insurance and Steam Power Company as 'the first and largest insurance company, where more than 10,000 boilers are enrolled,' the witness assumes that the former has no more inspectors than the latter, and therefore draws the conclusion that 'thorough inspection is out of the question.' This conclusion is based on a false assumption. The association has, I am informed, five or six regular inspectors and one or two occasional inspectors, all of whom reside in Manchester or in the immediate vicinity, from which it is evident that when required to inspect boilers situated in the South of England or any distant locality much time and expense would be wasted in travelling. The Boiler Insurance and Steam Power Company on the other hand, has twenty-seven regular inspectors, all residing near the centres of their respective districts, viz., London, Edinburgh, Glasgow, Liverpool, Manchester, Bristol, Dundee, Belfast—in short, in most of the important towns where steam power is employed. It is obvious, therefore, that as much less time will be spent in travelling, an inspector of this company must be able to inspect considerably more boilers than an inspector of the association, so that in reality the Boiler Insurance and Steam Power Company is in a much better position as regards the means of inspecting than the Steam Users' Association."

It will be seen therefore that by dropping a 2 from the number 27, and stating "it was a question with him whether the insurance company he referred to had more than 7 inspectors," Sir William Fairbairn was guilty of a serious injustice, and that the company, instead of having only one inspector for upwards of 1,400 boilers, had in reality one to every 370 boilers under its charge. Mr. Gray, when he learns the facts, must feel that one of the sources of his inspiration is not very pure, and that some at least who have undertaken to furnish him with information on the subject of boiler insurance and inspection have done him but scant justice in permitting it to convey an impression so false and misleading. It is to be regretted that a Government department should have been the medium, however unwittingly, for the issue of an official document containing statements so utterly one-sided and inconsistent with facts.

Now that the whole scheme has collapsed it is to be hoped, should the question ever again be revived, that greater care will be exercised in arriving at a true estimate of the work done by boiler insurance companies, and that the statements of no one company will be accepted as incontestibly true until they have been carefully verified, especially when such statements tell to the disparagement or discredit of others of its rivals with whom it may be in competition.

INSTITUTE OF ART AND INDUSTRY FOR MANCHESTER.

MUNIFICENT BEQUESTS.

The Manchester City Council will be asked at its meeting next week to sanction and materially support a scheme for the formation of a Whitworth Institute of Art and Industry on an extensive scale, and the provision of a woodland park and pleasure gardens. The scheme is formulated by the legatees of the late Sir Joseph Whitworth, who left a large sum of money to be expended by them for the benefit of the citizens and in sympathy with his known wishes. The proposals are to present to the city the private property known as Potter's Park, the erection and equipment of a museum of art and industry in the park, an enlargement of the present School of Art, the building of a central technical school to work in close relationship with Owens College, and the establishment of manual training schools, which may form a link between the public elementary schools and the central technical school. The whole scheme (inclusive of the present buildings of the School of Art and Technical School), valued at £50,000, represents a capital outlay of close upon £300,000. Towards this the Whitworth legatees offer in land, buildings, and money £135,000, to be supplemented by other donations in case the broad scheme suggested by them is carried out. The committee and guarantors of the Manchester Jubilee Exhibition have provisionally agreed to hand over for the purpose of the institute of art and industry their surplus, which is estimated at £40,000, and the governing bodies of the Technical School and the School of Art have expressed their willingness, on certain conditions, to hand over their property. The City Council will be advised by a special committee of their body to provide for the maintenance of the public park, and to obtain power to assist from the rates in the support of the institute. The annual expenditure on maintenance, &c., is estimated at £10,000. The museum of art and industry is to comprise five sections, as follow: (1) Fine art, painting, sculpture, &c.; (2) industrial art, textiles, wood and metal work, pottery, &c., books of design, and patterns; (3) mechanical, chemical, and textile industries and models; (4) commercial raw products, samples and patterns from the colonies and foreign countries, sent home by our consuls to show the industries and requirements of distant markets, with suitable expositions, lectures, &c.; (5) lecture halls and illustrative libraries, lectures, &c.

FAST RAILWAY TRAVELLING.

The London and North-Western Railway are making a bold bid for the through traffic between London and the North, and have announced that in future the trains leaving Euston at 10 a.m. will arrive at both Edinburgh and Glasgow at 7 p.m. instead of 8 p.m., as hitherto. The achievement is much greater than it appears at first sight. The distance between the two capitals by this route is a little over 400 miles, and this it has previously occupied 10 hours to accomplish, giving a rate of 40 miles an hour, including stoppages. In future, therefore, it will be necessary to traverse the distance in 10 per cent less time, or at the rate, including stoppages, of 44½ miles. When it is realised that this involves travelling at an average speed of about 50 miles an hour, it will be seen that it is a very high rate indeed, even for the best English expresses, when maintained over a distance of 400 miles. Under the new arrangement the company will run a dead heat with its rivals on the trip to Edinburgh, and win by 80 minutes to Glasgow, this being due to the fact that as far as the latter journey is concerned it has only to run 401 miles against 439 required by the rival route.

The East Coast Railways, however, are bestirring themselves, and have announced that from the beginning of next month their fastest expresses on the above journeys will be accelerated by 30 minutes, the Edinburgh journey being accomplished in 8½ hours, and the Glasgow one in 9 hours and 50 minutes. Their speed to Edinburgh, therefore, including stoppages, will be at the rate of 46½ miles over 392 miles, as against 44½ over 400 miles by the L. & N. W. route. It will thus be seen that the London and North-Western Railway has at least one rival determined to stick close to its heels, and even to outpace it over equal distances.

It has not yet been stated what steps the Midland Company propose to take to meet the advances made by its rivals on either hand. The pace is largely determined by gradients, and in this respect the Midland, at least over a large portion of its course, is heavily handicapped as compared with its rivals. Between London and Leicester it rises three times over 400 feet, while between Settle and Carlisle it mounts upwards to a height of over 1,100 feet. The Midland Company, however, is one that is not easily beaten or dismayed by difficulties; indeed, had it been so, it is probable the line via Hellifield would never have been constructed, and we shall watch the counter move of this company with considerable interest and curiosity.

THE RIVETING OF IRON AND STEEL VESSELS.

The adoption of high pressures of steam—*e.g.*, in the triple expansion type—by marine engineers, has led to advances in boiler-makers' practice, although steps had been made in the onward path previously in the drilling of rivet holes and the use of mechanical riveters. These operations are necessarily linked together, though it may be admitted in the case of two-ply work machine riveting has been accomplished with punched holes, and proved commercially successful; still, to make success certain in three or four ply work, drilling is essential. Half or quarter blind holes are not unknown in shipbuilding, nor yet the use of the drift by riveters, which with machine riveting would materially increase the cost, as fair holes are a *sine qua non.* Hence has arisen the practice in boiler-making establishments of drilling plates after they have been bent to shape and fitted together, the Board of Trade granting a higher pressure in boilers so constructed. At first the rule in question was much condemned, especially by those manufacturers who had not the necessary appliances; and no doubt similar action on the part of the Committee of Lloyd's Register, in penalising punching in mercantile shipbuilding, would also meet with opposition. Be this as it may, the time ought and will come when the brutal practice of punching material will universally give place to drilling, as, in plates of half an inch in thickness and upwards, authorities state there is a loss of tenacity from 10 to 23 per cent in iron plates, and from 11 to 33 per cent in plates of mild steel, while on the other hand, there is no appreciable loss in the case of drilled holes. Doubtless, to some extent, annealing, rimering, or countersinking may remove the bad effects of punching; but now that mild steel is being so generally used in ship construction, the substitution of drilling for punching is of greater importance. Again, when holes are drilled, they can with advantage be spaced closer. Indeed, in steel vessels, rivets in the butts of the shell-plating have to be, by the rules of Lloyd's Register, twelve and a half per cent closer than in iron vessels, a requirement recently modified, but only so far as the back row of treble-riveted butt-straps is concerned. Experience with closer riveting in the oil-in-bulk steamers also tends to show that for absolutely tight work the ordinary spacing of riveting is not sufficiently close. Again, with mechanical riveting there is an absolute certainty of the filling of the rivet holes, owing to the heavy and direct blows or powerful squeezes of the riveting machines. Another advantage—to which we do not remember attention having been previously drawn—is that, as the act of riveting is momentary, the point of the rivet is not rendered brittle by being repeatedly hammered when at a low heat or cold. Even rivet-iron of Lowmoor quality is liable to this injurious result. At all events, the writer has had occasion to test the quality of material forming a rivet one and a half inch in diameter, on account of the point having, during the night after it had been riveted, fallen off and shown a very brittle fracture. The material, on being tested, however, stood the necessary tests, and only broke under a tensile stress of thirty tons per square inch. It is considered preferable to effect heavy steel forging work by hydraulic pressure, and why should not steel riveting be similarly effected ?

No doubt there are practical difficulties in shipbuilding obviating a universal adoption of machine riveting. It is not such an easy task to drill all the holes in the shell of a ship, after it is fitted, as it is to drill the holes in the shell of a boiler, but, were it compulsory, it could and would be done. Indeed, where manual labour is expensive, or time presses, on old work, such as fitting doubling strakes, the writer has seen drilling carried on by steam power, specially arranged for one vessel, in one of the Liverpool graving docks.

It is, however, probable that electro-magnetic drilling machines, as designed by Mr. F. J. Rowan, of Glasgow, will meet the requirements of shipbuilders. Already they have been in use at Messrs. McMillan and Co.'s yard at Dumbarton, and after a little practice the men worked the machines with great rapidity, drilling twelve ⅞in. holes in the shell plating of a vessel in less than fourteen minutes, including the time occupied in shifting the machine. Messrs. William Denny and Bros. have also constructed an electrical drilling machine, but without holding-on magnets. This was used in drilling the rivet holes in the butt joints of a large steamer, and the same firm have used an electro-magnetic machine for drilling holes of 1¼in. diameter in the engine seat of the steamship Pukaki.

Apart from the operations of drilling, countersinking, &c., there are other practical difficulties in adopting mechanical riveting to shipbuilding. Without, however, underrating these, we feel assured that even with the appliances already designed by Mr. R. H. Tweddell, and others, hydraulic riveting might be adopted to a much greater extent than is already the case. Some enterprising shipbuilding firms, indeed, have for years been employing hydraulic power for riveting framework, beams, &c., where the work could be brought to the riveting machine, and also for the keels of vessels, but shipbuilders require to be convinced that it would pay to fit up complete installations of hydraulic power, capable of being utilised in any part of a vessel's hull. Here, undoubtedly, lies the difficulty, and an experiment on a sufficiently large scale alone can solve the problem.

Possibly other systems of mechanical riveting may provide a solution should hydraulic machines and their concomitants prove too expensive. Air threatens to be a competitor with water power; and although pneumatic riveting machines have come comparatively late into the field, they have been adopted in many bridge-building and some shipbuilding yards, and we may mention Allen's patent pneumatic portable riveter, which appears admirably adapted for any work. Then there is steam, which may yet again be employed. It has been successfully applied to the work of riveting the shell plating of vessels, the greatest success in this respect being attained in 1876 by Mr. John McMillan, of Dumbarton, at the time of the great labour dispute in the Clyde shipbuilding yards. Yet, again, there is electro-magnetic power, which, although hitherto only tried experimentally, may be expected ere long to come to the front. The existing electro-magnetic riveters have been designed by Mr. F. J. Rowan, Glasgow. They are specially noteworthy as solving the question of mechanical "holding up," impossible in the case of closing plates and strakes of plating in the shell plating of vessels when either hydraulic or pneumatic riveters are used. In the steam riveting already referred to "holding up" had also to be entirely performed by hand.

In Mr. Rowan's electro-magnetic riveters, the machine and the holder-up have each two sets of magnets, with the two poles of unlike denominations facing each other, the rivet being held up by a bolster or dolly, and kept to its work by a spring. A riveter of this description, worked by an electric motor, has closed one-inch rivets in ten seconds, delivering from 100 to 150 blows per minute.

In concluding, attention is directed to the heating of rivets. Now that steel is being used for rivets in shipbuilding, the necessity of having them uniformly heated, and in no case "burnt," is accentuated. As is generally admitted, "steel is a material which suffers even greater injury than iron from being overheated." Again, steel rivets of the larger sizes being more difficult to manipulate than similar iron rivets, there is a greater inducement to burn the points. Even from an economical point of view this burning is to be deprecated, as many rivets become wasters. It is, therefore, astonishing that the crude method of heating rivets in common portable hearths has continued so popular, as, when small furnaces have been employed, good results have followed, even with only a chimney draught, while there does not appear to be insuperable difficulties in having forced draught furnaces for heating rivets in any part of the hull of a vessel. In constructing the Forth Bridge, furnaces fed with liquid fuel have been largely used for the purpose. Steel rivets, judging from experience with Lowmoor iron ones in the keels of vessels, will be especially liable to oxidation (especially if they have been overheated or burnt) when they come in contact with sea-water. Possibly this, amongst other factors, has led Messrs. Yarrow and Company, the torpedo boat builders on the Thames, to reverse the ordinary practice, and fit flush rivets with countersunk heads in the shells of their vessels, held up from the outside, and the points knocked down from the inside of the hull.

Certainly by this means, with accurately countersunk holes and rivets, better watertight work will be secured, while the material most exposed to deteriorating influences will not be so liable to be burnt.

THE MEASUREMENT OF EARTHQUAKES.

A LECTURE on the above subject was delivered on Friday, the 1st inst., at the Royal Institution, by Professor Ewing, of Dundee. In the course of his remarks Professor Ewing pointed out that seismology was a science with two sides, one geological, the other mechanical. The geologist attacked the subject by at once attempting to refer earthquakes to their source in the crumbling, tearing, or slipping of strata, in volcanic eruption, in the collapse or explosion of subterranean cavities, while the mechanical student of earthquakes, on the other hand, concerned himself with the character of the motion that was experienced, and with the means by which an earthquake spread from point to point by the elastic vibration of rock and soil. The first business of the mechanical student, therefore, was to find out exactly how the ground moved during an earthquake, to determine by direct measurement the amount and direction of every successive displacement, and the velocity and rate of acceleration at every instant while the shaking went on. This, the lecturer stated, was the problem of seismometry, and he gave some of the results which had been obtained in the measurement of earthquakes in Japan, where earthquakes happened with a frequency sufficient to satisfy even the most exacting seismologist. It had been estimated that one or another part of that empire was shaken every day, and in Tokio, where the measurements had been made, there was an earthquake, on the average, about once a week.

Professor Ewing said that most early attempts to reduce the observing of earthquakes to an exact science had failed, because they were based on a wrong notion of what an earthquake was. It had been imagined that an earthquake consisted of a single isolated jerk, or of a few jerks, easily distinguishable from any minor oscillations that might accompany them. The old column seismometer, for instance, attempted to measure what was called the intensity of the shock by means of a number of columns of various diameters which stood like ninepins on a level base. It was expected that the shock would overthrow the narrower columns up to a breadth which would gauge the intensity of the disturbance, and also that the line in which they fell would show the horizontal direction of transit of the earthquake wane.

The fact was, however, that such columns fell most capriciously when they fell at all, the reason being that in an earthquake there was no single outstanding impulse, but a confused jumble of oscillations, very numerous and very irregular, which shifted their direction with such rapidity that a point on the earth's surface wriggled through a path like the form a loose coil of string might take if it were ravelled into a state of the utmost confusion.

The mechanical problem in seismometry was to find a steady point, to suspend a body so that some point in it, at least, should not move while this complicated wriggling was going on; the steady point would then serve as a *datum* with respect to which the movement of the ground might be recorded and measured. The simple pendulum had often been suggested as a steady-point seismometer, but in the protracted series of oscillations which made up an earthquake the bob of a pendulum might, and often did, acquire so much oscillation that, far from remaining steady, it moved more than the ground itself. To prevent the independent oscillation of the body whose inertia was to furnish a steady point, it was essential that the body should be suspended or supported astatically—in other words, so that its equilibrium would be very nearly neutral. The complete analysis of the ground's motion was effected by a seismograph, which resolved it into two horizontal and one vertical component, and recorded each of these separately, with respect to an appropriate steady point, by means of a multiplying index, on a sheet of smoked glass which was caused to revolve at a uniform rate by clockwork, which was started by the action of the first tremors of the earthquake. The record drawn on the plate gave every possible particular regarding the nature of the motion at the station where the seismograph was placed. A complete set of the apparatus, as made by the Cambridge Scientific Instrument Company, was shown in action. Professor Ewing also described and showed his duplex pendulum seismograph, which drew upon a fixed plate of smoked glass a magnified picture of the horizontal motion during an earthquake.

A number of autographic records of Japanese earthquakes were thrown on the screen, and their principal features were described. In general the motion began with small tremors of high frequency, which were probably transmitted by normal vibrations of the crust; these died out at an early stage in the disturbance, but usually not until transverse motions of larger amplitude and longer period had begun. The whole went on with irregular fluctuations for two or three and sometimes even for ten minutes. As a rule, the horizontal movement was much larger than the vertical. Each single movement usually occupied from half a second to two seconds. By means of the seismograph earthquakes were quite perceptible in which the greatest extent of motion was no more than one one-hundredth part of an inch. In one case, on the other hand, as much as an inch and three-quarters had been registered, and even that extent of motion was in an earthquake which did little damage, so that there was reason to expect a severely destructive shock (such as had not occurred in Tokio since the present system of seismometry was developed) would show still more motion.

Professor Ewing concluded his lecture by exhibiting seismographic records he had recently taken on the new Tay Bridge to examine the shaking of the bridge during the passage of trains. The instrument had been placed on the southmost of the great girders, where it was expected that the vibration would be a *maximum*. The records showed that the greatest horizontal motion never exceeded one-eight of an inch, even when a train was passing the seismograph—a fact which spoke well for the stiffness of the structure. Nevertheless, by watching the seismograph one could see the index begin to oscillate whenever a train came on at the Dundee end of the bridge, a distance of one and one-third mile from where the instrument was standing. The movement began with longitudinal oscillations through something like one five-hundredth of an inch. When the train came a good deal nearer transverse oscillations also were recorded; and the bridge did not cease to shake till the train had passed off at the other end.

A NOVEL USE FOR PARAFFIN.

THERE seems no end to the multitudinous fashions in which mineral oils come to the aid of man. Paraffin has well nigh supplanted the various oils and greases previously in use throughout the whole world; even to the remotest Hawaiian, Tahitian, or Fijian Isles, where the cocoa palm has ever afforded the purest of vegetable oil. Nor as an illuminant alone has the kindly earth oil been turned to use. It has revealed such precious properties of soothing and healing, such excellence as lubricating oil for machinery, it has yielded such varied preparations of vaseline for wounds and for toilet purposes, that merely to catalogue these would be a task. And now, to all previous services another is added—perhaps the most domestic of all. It seems that by the addition of a very small amount of mineral oil to boiling water and soap, almost all manual labour in clothes washing may be dispensed with; for at the end of half an hour the clothes will be found so clean that little further is required save to rinse them out in two or three hot and cold waters. The smell of paraffin is not pleasant during the boiling process; but after the final rinsing no trace of it (it is said) remains.

SELLER'S "COMPRESSION" OR "DOUBLE-CONE" VICE COUPLING.

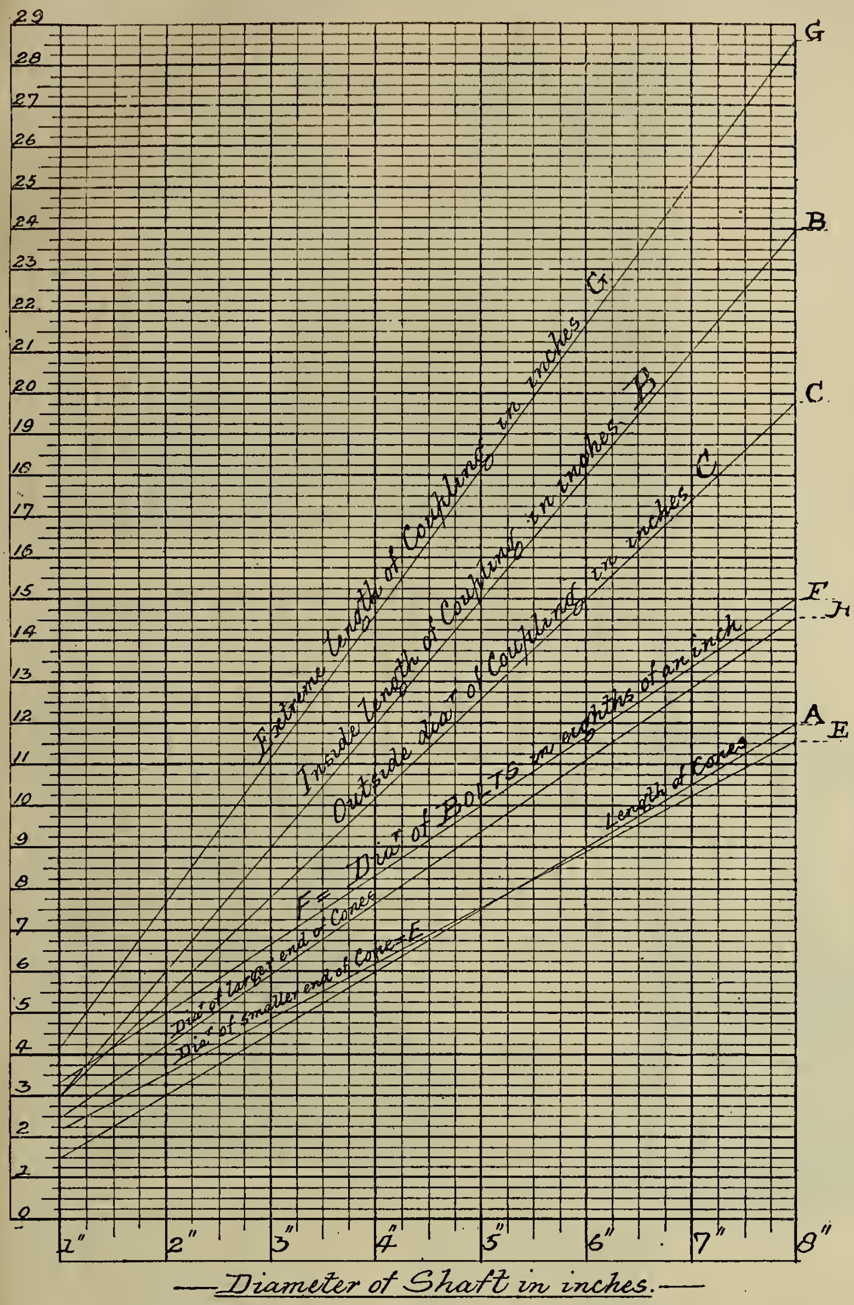


FIG. 2.

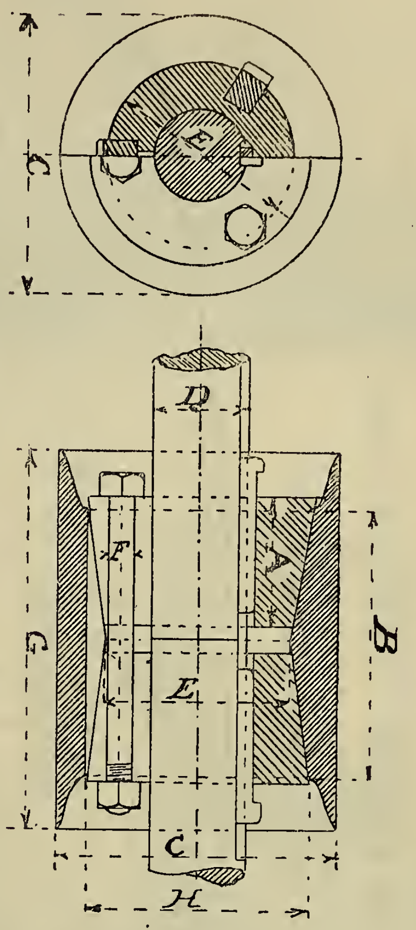


FIG. 1.

In connecting long lengths of shafting by means of what may be termed permanent or fast couplings (in distinction with what are usually termed disengaging or loose couplings), the Seller's coupling is most useful, from the fact that it is not necessary that the ends of the shafts should be of a larger diameter than the body of the same, as we find to be the case of the "half-lap" coupling introduced by Sir W. Fairbairn, and therefore wheels and pulleys may be readily passed over the ends to the desired position on the shaft. Another point in favour of the "Seller" coupling is that the two shafts are more easily coupled up dead in line than is possible with the ordinary face-plate coupling, inasmuch as, if in fitting up the latter a perfect fit on the shaft is not obtained, the process of keying on will tend to force the couplings out of square with the axis of the shaft, and will thus produce an alternate bending action on the same.

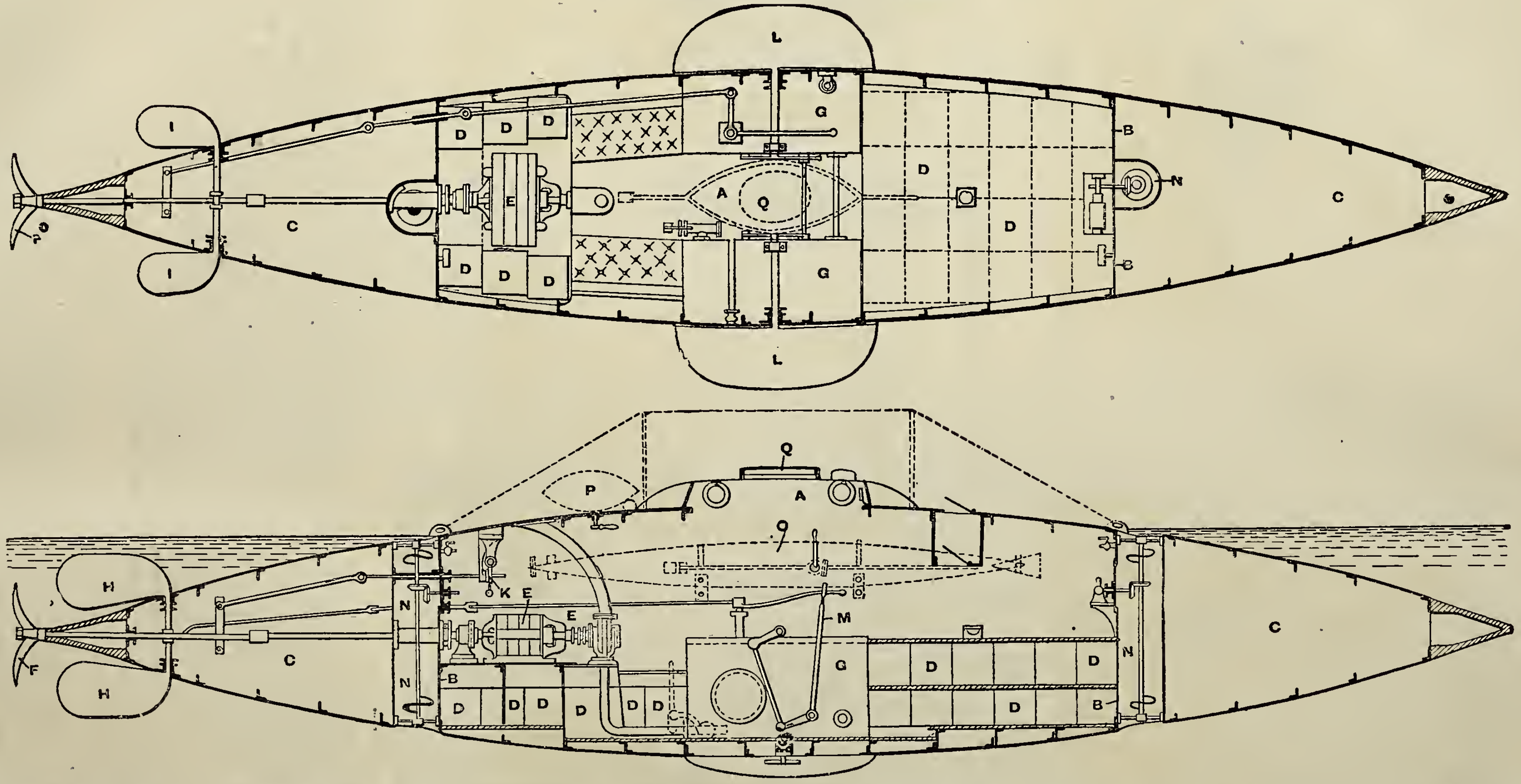
The illustration, fig. 1, shows the coupling in section and part elevation, and it may be briefly described as follows: Upon the shafts whose diameter is D are fitted two cones or sleeves of length A, and diameters E and H respectively. These sleeves are cut through on one side, as shown at the bottom of one of the square slots provided for the bolts, which latter are square in section, and whose duty is to force the two sleeves or cones together when placed inside of the "muff" or "box," which will be seen to consist of a double cone, of such a length as to suit the sleeves before described. The keys shown should fit sideways only, as the more usual method of fitting the keys to bear on the top and bottom would have a tendency to burst the sleeve.

The diagram, fig. 2, gives the proportionate sizes necessary for the various parts for shafts varying in diameter from 1in. to 8in., and will be found sufficiently clear without any further explanation than that the line F, giving the diameter of the bolts at screwed end, or size of square in body of the same, is, in order to make it more clear, made to a scale giving that diameter in eighths of an inch.

THE TECHNICAL EDUCATION BILL.—The Technical Education Bill which has just been circulated is said to meet with very favourable consideration from Parliamentary supporters of the movement for the promotion of technical instruction. The opinion, however, is expressed that it will require some amendments in detail, and with a view to the drafting of these an abstract of the measure is to be circulated among members of the Technical Education Association, for the purpose of examination and comment.

SUBMARINE NAVIGATION.

The "Waddington" Electrical Vessel.



Sanguine Americans have hazarded the opinion that submarine navigation would solve the problem of *mal de mer*, but it is more probable that neither submarine nor aërial navigation will ever be found of practical utility beyond a limited sphere. Probably in each instance the employment of these systems will be confined to war purposes. At all events, all submarine vessels hitherto built, or even only designed, have been intended for facilitating the destruction of an enemy's vessels. In the American Civil War this was on one occasion successfully accomplished, the Federal man-of-war, Housatonic, being sunk by one of these craft, which carried a spar torpedo; but the attacking vessel also sank by entering the aperture formed by the torpedo. This submarine vessel was driven by a screw propeller, worked by eight men, the crew, all told, consisting of nine persons. Although the foregoing incident has its painful aspect, it proved the practicability of submarine navigation; and if manual power had such a measure of success, it is but reasonable to suppose that, with more effective motive power and greater perfection of details, the submarine vessel may prove a most valuable auxiliary in naval warfare. Various methods of providing the mechanical force necessary for propulsion have since been proposed and tried. Steam has been used as the motive power, raised by the soda-potash process. Again, "stored steam," previously raised in an ordinary boiler, has been employed in the Nordenfelt vessels when submerged. Petroleum engines have also been adopted; but we are inclined to believe that electricity will be found to be *the* motive power for submarine vessels. As the success which has attended the Waddington electrical vessel confirms this opinion, a detailed description of it will be interesting to our readers.

It is three years since Mr. J. F. Waddington turned his attention to the question of submarine vessels, and he has to be congratulated upon being foremost in practically applying electricity to this class of vessel, and also in constructing the first electrically propelled vessel. It has recently undergone trials before the representatives of several European governments, and Count Candiani, of the Italian navy, and several other gentlemen, have accompanied the inventor below the surface of the water on various occasions. The illustrations herewith, together with the following description, will give our readers a good idea of the construction and equipment of the vessel in its

EXCAVATING MACHINERY USED ON THE MANCHESTER SHIP CANAL.

(For description see page 272.)

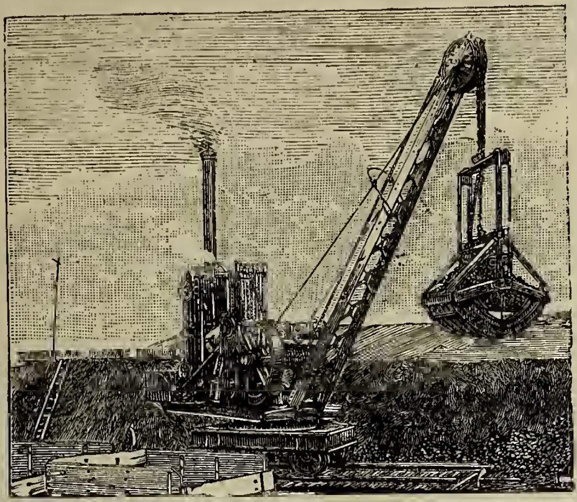


Fig. 1.

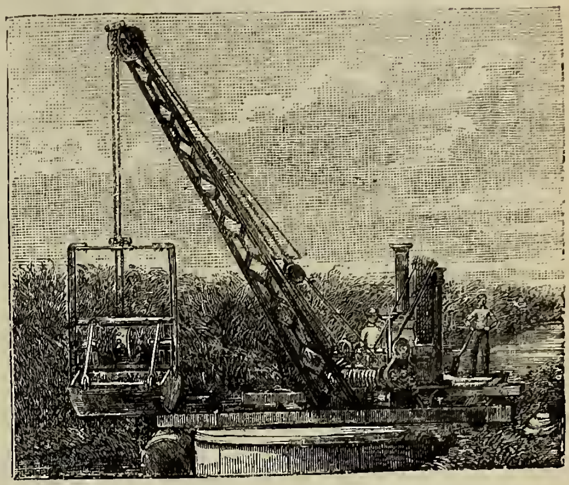


Fig. 2.

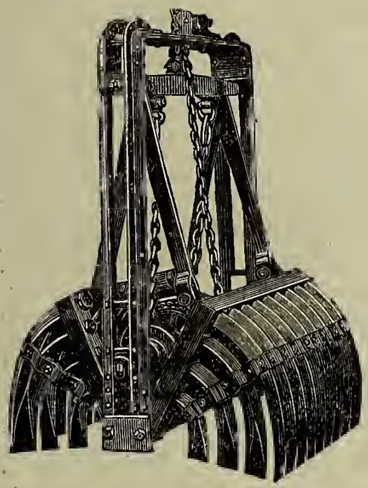


Fig 3.

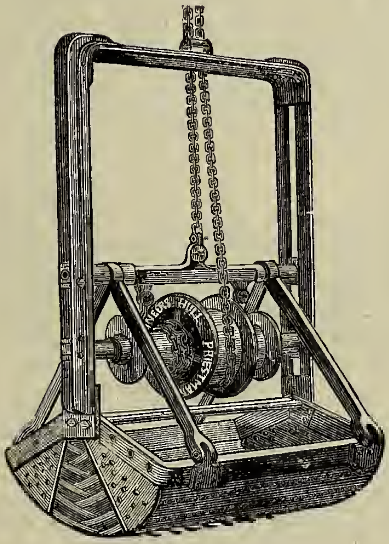


Fig. 4.

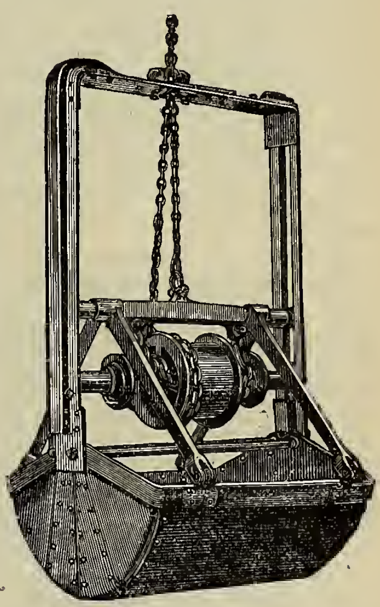


Fig. 5.

various details. Fig. 1 is a longitudinal section, and fig. 2 a sectional plan. The principal dimensions are: Length over all, 37ft., and diameter amidships, 6ft.; the hull of the vessel gradually tapering in a curve towards the stem and stern. Two bulkheads, BB, divide the vessel into three compartments, of which the two smaller end ones, CC, are utilised for the storage of the supply of the compressed air. The large compartment amidships is occupied by the electric motors and accumulators, pumping, and steering apparati, seats for the crew, &c. At the centre of the vessel, and at the upper portion of the hull, is the conning tower, A, provided with several circular side lights, as well as with an oval-shaped scuttle, Q, on top, for entering the interior, provided with a water-tight door secured from the inside. The motive power, as already indicated, is electricity, which is stored in forty-five large accumulator cells, D, having 660 ampère hours' capacity each. They are coupled up in series to an electro-motor, E, which drives the propeller, F, direct, at about 750 revolutions per minute. The motor, when working at full speed, uses a current of about 66 ampères and 90 volts., developing 7·96 electrical H.P., which would drive the vessel for ten hours at a rate of eight miles an hour, thereby enabling it to go eighty miles at full speed without replenishing the accumulators, while at half speed the vessel would travel a distance of 110 miles, or at a slow speed for a distance of about 150 miles. Amongst the advantages obtained by the adoption of electricity as the motive power are the following:—

1. The moderate size and weight of the vessel, rendered possible by the absence of boiler, water, &c., allows of such craft being carried on a war vessel's davits, ready for use, the same as any ordinary steam launch. This is a most important advantage, as, if a few of such submarine vessels were carried on every warship, they might frequently be utilised in placing mines under, or in discharging torpedoes at the under-water portions of the enemy's vessels, by being able to approach unseen. Possibly, owing to the erratic conduct of torpedoes, it would be found that the former mode of operating would be most effective.

2. There is no attention called to the vessel by the smoke and waste steam accompanying the getting-up of steam in submarine vessels, using the ordinary motive power. As soon as the accumulators are charged the Waddington vessel is ready to proceed at a moment's notice.

3. There is no consumption of air in promoting combustion in boiler furnaces, and no heat or poisonous gases are given off to pollute the air in the vessel—a very important characteristic for a submarine vessel.

4. Electricity is more economical, as, for instance, when the vessel's machinery is stopped the motive power is not subject to waste, as in the case of steam power.

5. Largely owing to the motive power in the Waddington being electricity, the crew consists of only *two* persons. Indeed, *one* man would suffice were it not advisable to have a second available in case of emergency, such as a sudden attack of illness disabling the man in charge, who, by the way, has all the levers in reach (when at his post in the conning tower) for controlling the movements of the vessel by the steering gear, engines, &c.

Completing our description of the vessel as shown in our illustrations, large water-ballast tanks, G, are fitted for the purpose of reducing the buoyancy of the vessel when preparing for submersion, or for increasing the buoyancy when it is desired to bring back the vessel to the surface. At the after end there are two vertical rudders, HH, and two horizontal ones, II, the latter ones being used for maintaining the vessel on an "even keel" when it is being propelled under water. So as to avoid any mischance resulting from the man in charge losing his presence of mind in a moment of emergency, the rudders, II, have been arranged to work automatically by a method in which the electro-motor, K, works into worm gearing, and so arranged that the slightest cant up or down causes the rudders to be put over to meet it, and then stop in the same manner as a steam steering gear. The side planes, LL, are also noteworthy. They are balanced, and can readily be inclined to different angles by means of the lever, M, and are utilised in causing a diving action when the vessel is progressing in a fore and aft direction. Reliance is not, however, placed upon the side planes for the work of submerging or emerging the vessel, as has already been indicated. In ordinary practice the *modus operandi* in descending beneath the surface of the water is by means of the vertical propellers, NN, placed in recesses close to the bulkheads at the ends of the compartments, CC, nearer to amidships. The recesses are vertical tubes, open at each end, extending right across the vessel so as to leave a clear course for the water from the vertical propellers, NN, which are worked by separate motors, and may be used separately or together as the occasion may require for raising or lowering the vessel. Special precautionary means are provided whereby, in the event of a sudden leak or other emergency, a heavy weight, attached at the bottom of the vessel, can be released from the inside and cause the craft to emerge.

The offensive equipment of the Waddington must not be overlooked. Two locomotive torpedoes, O, shown in dotted lines in fig. 1, one being on each side of the centre line, are secured by grips, which can be cast adrift from the inside of the vessel. At the same time, and by the same action as the grips are released, the propelling motor of the torpedo is started. A mine torpedo, P, also shown in fig. 1, is also carried, for the purpose of attacking any vessel at anchor having its torpedo nettings in position. Attached to the mine is an electric wire, which can be readily paid out of the vessel, and by means of which the mine can be fired from a distance. The portable guard rail and stanchions, provided for shipment when the vessel is acting as a surface boat, shown in dotted lines in the longitudinal sectional view, fig. 1, form a very necessary adjunct for the vessel when in a seaway.

A brief description of the ordinary manner of handling the vessel will not be without interest. In the first instance, the water tanks, GG, are filled, immersing the hull, so that only the conning tower is above water. There is then only a few hundredweight of buoyancy remaining. The large motor, E, is then started, and a speed of say four to five miles an hour attained. The side planes, L, are inclined by means of the lever, M, and the vessel thereby submerged. By regulating the angle of the side planes and the speed of the after propeller, any reasonable depth may be maintained. If it be desirable to submerge the vessel without forward motion, only the vertical propellers, N, are used, and similarly by the regulation of their speed the extent of immersion can be controlled. The vertical propellers may also be utilised for immersing or emerging purposes when the vessel is progressing in a fore or aft direction, but in such instances the inventor prefers to use the side planes. The two end compartments, CC, contain a supply of compressed air, from which it readily passes as required to the working compartment, the bad air escaping through a valve as soon as the pressure inside becomes greater than outside. The compressed air need, however, only to be made use of when the vessel is below the surface for more than six hours, as the centre compartment contains sufficient air for two men for that period.

We cannot but express the hope that the ingenuity and enterprise that has been exhibited in this electrically propelled submarine vessel will meet with due encouragement. Surely the British Government, which could expend such a vast amount in securing the "Brennan" torpedo design, might do something in encouraging inventors of submarine craft, and in that event, if impartiality is displayed, Messrs. J. F. Waddington and Co., Seacombe, near Liverpool, would not be in the background. As it is, they appear determined to abundantly prove the practicability of the invention. We also understand they intend to utilise compressed air as a motive power, as at present the firm is engaged in designing a larger and more powerful vessel of the same type as the Waddington, with the exception that "electricity" would give place to "air."

EXCAVATING MACHINERY USED ON THE MANCHESTER SHIP CANAL.

In our issue for 2nd March last we illustrated and described one of the steam navvy types engaged on the Manchester Ship Canal works, and from the particulars we then published it will have been seen that this machine, to work at its best, required to have a head of soil in front of it—in other words, that it was placed at the bottom of a cutting in order to work its excavations forward. Consequently it demanded a preliminary cutting or excavation to be prepared for it before it could be set to work to its best advantage. We are, therefore, not surprised that the enterprising contractor of the Manchester Ship Canal should have elected to introduce machinery to supplant what would have otherwise to be done by manual labour, by supplementing the operations of the steam navvy with an excavator, able, when set in position, to dig or excavate a cutting from the level surface, and it is this last-mentioned machine which we illustrate in the accompanying figs. 1 to 5. We had an opportunity of seeing this excavator at work on the Runcorn section, and our fig. 1 illustrates the manner in which the machine is rigged up, making a cutting at its side, or delivering the excavated material into railway trucks running on rails laid alongside of it. Like the steam navvy before alluded to, this excavator runs on rails, and consists, roughly speaking, of a portable steam crane, to the chain of which a peculiarly shaped bucket or excavator is fixed. The vertical engine, boiler, and crane are mounted on a trolly. The engine works upon a cast-iron foundation, with wrought-iron pillars securely fitted in the centre, and wrought-iron hot-water feed tanks are supplied, upon which the boiler stands. The boiler is of the vertical type, with steam and water fittings complete, and the engine works with two cylinders fixed to strong iron side frames, for the purpose of working the lifting bucket direct. In short, the engines are designed for working the self-acting bucket and grabs at a great speed, together with all necessary working parts, including lifting, lowering, and turning gear, hot-water feed pumps, with suctions and delivery pipes complete. The crane jib is of wrought iron (excepting in the two smaller sizes, in which wood is used). The chains are made to work the bucket at a depth of 25ft.—two of which are used for opening and shutting the bucket—but they can be made to work at a greater depth if required.

It may be inferred from the foregoing the characteristic feature of the machine consists in the bucket attached to the end of the crane chains, and there are three different types of the buckets or grabs made to suit the various classes of material to be dealt with, capable of dealing with from three hundredweight to two tons of material at one haul. These three different types are illustrated in figs. 3, 4, and 5, as designed for a variety of purposes, such as excavating soil, gravel, sand, &c., lifting blasted rock, dredging docks, harbours, rivers, or canals—in which case it is mounted on a barge, as in fig. 2. Each of the three types is self-filling and discharging, the strut, side frames, and shafts being made of wrought iron, with cast-iron drums for regulating the two chains required in opening or closing the scoop. The bottom or grabbing part of the scoop differs in each case, as will be seen from the illustrations. Thus, for very stiff material the grabs are constructed with long powerful steel tines, fitted into strong wrought-iron frames, as in fig. 3; whereas for hard sandy material, a grab with interlocking tines set close together is necessary, as shown in fig. 4; while for lifting grain, &c., the arrangement shown in fig. 5 will commend itself. The buckets or grates can be made semicircular, when necessary, for sinking cylinders, &c., or, when working in very sticky material, self-acting scrapers are provided for the purpose. We may add here that if necessary the engine can be fitted with a pulley for ordinary purposes, such as driving pumps, saw benches, mortar mills, or pile driving when not required for dredging or excavating purposes, in which cases the bucket or grabs may be detached.

Coming to the working, the attendant in charge allows the bucket or grate to fall open into the material to be lifted out, its own falling weight ensuring it to lodge itself into this material, when, by working the closing chain, and thus shutting the scoop, it embeds itself further into the material; after which the bucket is raised, and the crane pivoted round over the place or trucks into which the lifted material has to be discharged, when the bucket or grate is again opened, allowing its contents to fall accordingly. The open empty scoop is then swung back to its work, and the same operation is repeated.

As to the working capabilities of this machine, we append the approximate quantities of material these machines will raise and discharge per day of ten working hours, with an average height of lift of 20ft. from ground level, worked by one man only.

Size of Crane.	When using the Grabs.		When using the Buckets.		
	Excavating Clay, &c.	Lifting Coke and Cinders, &c.	Small Coal, Sand, and Shingle—Barges to Quay.	Grain from Ship to Quay.	Mud in Dredging.
Cwts.	Tons.	Tons.	Tons.	Quarters.	Tons.
2½	..	..	..	..	100
5	..	..	..	..	175
10	150	125	200	1,200	250
20	300	200	400	2,400	500
30	400	275	550	3,200	650
40	500	350	700	4,000	800

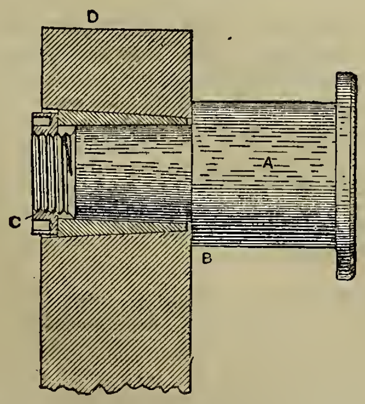
As this machine will probably be used for dredging purposes when the Manchester Ship Canal is completed, we may say that the makers have supplied dredging plant on this principle capable of raising 3,000 tons of mud in ten working hours, and as it takes up much less room than the ordinary dredgers, it can be used in dock corners, quay sides, and amongst shipping, where it would be impossible to work the ordinary plant. Another advantage over the latter is, that by keeping a duplicate bucket or grab, the great delay arising from the wear and tear of the ladder and buckets of the ordinary dredger may be avoided, and as it can be worked at any depth it can be employed in very shallow water. Attention may also be directed to the fact that when mounted on barges for dredging purposes, the barge can be propelled by a screw worked by the dredger engine, without any other engine on board.

The cost attending the working of this excavating and dredging plant may be inferred from the following particulars taken from actual practice. Sand has been removed and loaded into railway trucks under a penny per cubic yard. Foundations for railway work, costing sixpence per cubic yard, were reduced to twopence per cubic yard by employing this machine. Dredging at a certain harbour which used to cost one shilling per ton, is now done for threepence, while numerous other cases could be cited.

In conclusion, we may observe that the makers, Messrs. Twistman Brothers, Holderness Foundry, Hull, have supplied upwards of 400 of these machines, and now number amongst their customers most of the principal governments of the world.

A NEW METHOD OF SECURING CRANK PINS.

The accompanying illustration shows the method of fixing a crank pin so that it may easily be removed, described in our last issue, (*see page* 262 *ante*). As we then stated, the pin is secured by a taper bush, which is accurately fitted to the hole in the crank, and also cut from end to end to afford a little elasticity and allow for expansion and contraction. The bush thus acts as a thin wedge, and by tightening up the nut on the end of the pin it is forced home, and is stated to be held as rigidly as if it had been forced in position by hydraulic pressure.



SPIRALLY WELDED TUBING.

One of the most interesting papers read at the recent Boston meeting of the American Institute of Mining Engineers was that by Mr. James C. Bayles on "Spirally Welded Tubing," describing the manufacture of pipes from strips of steel or iron skelp, wound spirally, heated only along the over-lapping edges, welded by hammering, and finished into pipe of uniform diameter and of such length as may be found convenient in handling and transportation. Such pipes are now manufactured on a considerable scale in the United States, of sizes which will soon include everything between 4in. and 30in., and as much larger as may be needed. The process and product are likley to be of interest to engineers in all departments of professional work. The raw material of the industry is the ordinary sheet iron or steel of commerce, of such length and width as is convenient to roll. The range of the gauges of metal which can be employed has not yet been determined. The lightest metal thus far successfully made into pipe is No. 29 iron, and the heaviest No. 14 steel. Heavier machines are now building which will bend steel 0·165in. in thickness, or No. 8 of the Birmingham gauge. Probably No. 20 or No. 22 will be the lightest used in making commercial pipes. To get a welding heat with such thin metal and not burn or fuse it is a delicate operation. The gauge of stock which may be used when great strength is desired, depends upon the diameter of the pipe, the stiffness of the material, and the rate of speed desired in running the machine. Heavier metal can be used in an 8in. or 10in. pipe than one of the 4in., as the greater radius of curvature involves less difficulty in bending and forming it. The range of practicable gauges is wide enough to meet all the requirements of strength in ordinary service. The heating of the pipe is secured by one or two blow pipes of water, gas, and air. A special machine is used for welding. Mr. Bayles believes that there is a large and unsatisfied demand for sizes of wrought iron and steel pipe for uses in which cast iron is too costly or cannot be trusted, which seems to be fully met by the spirally welded tubing.

ALUMINIUM.

The search after cheap aluminium still continues. The various bronzes and alloys into which aluminium enters promise to possess such wonderful properties of strength and ductility, that a large market is sure to open to the metal immediately it can be produced at a moderate cost. Therefore, inventors have the certainty of reaping a rich prize if they can only solve the problem before them. The Cowles Company have already got an electric furnace to work in this country for the production of aluminium alloys. Dr. Kleiner's process is being actively pushed, while the old Deville process has been greatly cheapened by the introduction of the Castner's method of manufacturing sodium. During the last few days another method of manufacture, already in operation at the works of Messrs. Krupp, at Essen, has been introduced into this country by the Alliance Aluminium Company, of King's Head Yard, E.C. It is the invention of Professor Curt Netto, of Dresden, and is a chemical process based on the displacement of aluminium from its ores by metallic sodium. The ore used is cryolite, a double fluoride of aluminium and sodium. This is ground to a fine powder, and is fluxed with common salt. The ore is then melted in a reverberatory furnace, and when quite liquid is run into a ladle. When in this condition, ingots of solid sodium are forced to the bottom of the ladle, and are then held until they become volatilised, the work of a few moments only. The gaseous sodium rising through the molten cryolite displaces a part of the aluminium, which collects in a metallic form at the bottom of the ladle. The greater part of the slag is then skimmed off, and the remainder poured into an iron crucible to cool. When the mass is turned out a solid ingot of aluminium is found at the bottom. The whole of the aluminium in the original charge of ore is not obtained at each operation, and the slag is therefore returned to the furnace with more cryolite. After the first charge the addition of salt is not required, as the slag serves the purpose of a flux.

For each pound of aluminium obtained there is required about 3½lb. of sodium, so that it is important that this metal should be obtained cheaply. The Alliance Company manufacture it at their works, the process, as described to us, being as follows: Pure caustic soda is melted in a pan, and then ground coke is stirred into it; 100lb. of the mixture are ladled at a time into a long narrow retort, lying in a furnace. The carbon effects the reduction of a part of the soda, metallic sodium being distilled off and caught in a condenser, while carbonate of soda is left in the retort. When the reduction is complete the carbonate of soda is run off, and a fresh charge introduced, and so the process goes on. We were not informed what was the cost of the metal obtained, but it should not be greater than that obtained by the Castner process, which is stated to be 1s. a pound. Possibly it is less.

On Monday last we saw a 5lb. ingot produced, the time occupied from charging the furnace to weighing the ingot being less than an hour. The cast was one of a series which had been going on all day, and was carried out by unskilled workmen with a small experimental plant. It is claimed that the metal produced is pure, and that in this respect it has an advantage over that obtained by the various electric processes. The cost of its production is set down at 6s. a pound, while the present selling price is 48s. a pound. Since aluminium bronze requires only 5 to 10 per cent of aluminium, while steel and iron only need to be alloyed with one-tenth per cent to obtain the full benefit of the combination, it is evident that aluminium at 10s. a pound would be a commercial article for which there would be a large demand. —*Engineering.*

THE MAXIM AUTOMATIC GUN.

An automatic 3-pounder gun, which seems destined to play a great part in the warlike operations of the future, was tested at Erith a few days ago in the presence of the representatives of the War Office, who were so greatly struck by its performance that the Maxim Company has been requested to construct a 12-pounder upon the same principle.

The gun lately tried is merely an application of Mr. Maxim's well-known system on a larger scale. It has the appearance of the ordinary quick-firing 3-pounder, is mounted on a cone in the same manner, and is trained by a crutch on which the shoulder of the gunner rests.

When the gun is loaded and the trigger is pulled the barrel of the gun recoils a distance of four inches, the breech remaining closed during the recoil. When, however, the barrel returns to the firing position, the breech block is thrown downwards, the hammer is cocked, and the empty cartridge is ejected, the breech block remaining down until another cartridge is introduced. The act of placing the cartridge in the chamber liberates the block, which rises instantly, closing the breech, and the gun can be fired again. After firing the gun in the way described, the trigger was fixed in the pulled position, a cartridge was then thrust into the chamber, and when the breech closed the cartridge was fired and its empty shell ejected. On introducing another cartridge it was fired in the same way without the intervention of the trigger, and so on with an indefinite number of cartridges, the gun doing all the work except that of placing the cartridges in the chamber. This gun weighs no more than the ordinary quick-firing gun of the same calibre; the strain on the mounting is less, enabling it to be fired from a light torpedo boat without damage to the deck; and the rapidity of fire is increased with only one-half the usual gun detachment to work it.

We understand the Maxim Company have just concluded an agreement with Herr Krupp under which he will have the exclusive right for twenty years to manufacture Maxim guns for Germany, while for their work in this country they are erecting large works at Crayford, in Kent, which will be fitted with machinery of the newest type.

CORRESPONDENCE.

We do not hold ourselves responsible for the opinions of our Correspondents.

THE STEAM ENGINES AND BOILERS BILL.

To the Editor of "The Practical Engineer."

Sir,—Your correspondent, "Ignorance," contributes another amusing anecdote, intended to shake public confidence in the way that boiler inspection is generally carried out. He asks, "Who is to decide when inspectors differ?" But, although he claims to have furnished sufficient particulars to judge of the case, he does not show in what respects the inspectors differed, and his sole reason for condemning the efficiency of the first inspection was the refusal of the second company to insure the boilers at the ordinary working pressure. Now, let us suppose, for the sake of argument, that these two companies had been the Admiralty and the Board of Trade. The factor of safety required by the former is 2½, whilst the latter are not satisfied with less than 5 to 6. Now, the Admiralty inspector has no difficulty or hesitation in deciding that the boiler is fit for the pressure required, as the structure possesses nearly twice the strength required by his employers. But the Board of Trade inspector finds the boiler rather weak for his rules, and being required to give the maximum safe working pressure, his inspection requires to be very careful, which causes him to check and re-check his particulars, a precaution less necessary with the other inspector, who found everything about double the required strength. Seeing that the two highest authorities in the country differ as to what should be regarded as a proper factor of safety, it is not surprising that this should extend down to boiler insurance companies; but it has been left to your correspondent, "Ignorance," to suggest the ability to decide this question as one of the qualifications required to fit a boiler attendant for his work. I think the other specific qualification mentioned by "Ignorance" in a previous letter was the relative depth to which the visual organ of an inspector could penetrate a half-inch steel plate. When the bill was first proposed some of your correspondents were afraid that they would require to qualify in Greek, Latin, and the higher mathematics. But these would be trifles compared with the tests required by "Ignorance." It would be a libel on a class of intelligent, hard-working men to assume that "Ignorance" is in any way acquainted with the management of steam boilers; but the ignorance displayed throughout his three letters will tend to dissipate the prejudice which still exists in some quarters against boiler inspection. It is to be hoped, for this reason, that "Ignorance" will continue to favour your readers with a few more of the "many cases" which have come under his notice, and let the particulars be as full as possible. It is a pity to allow doubts to be raised as to the authenticity or meaning of these anecdotes through excess of modesty in withholding details.—Yours, &c.,
Boiler.

June 4th, 1888.

To the Editor of "The Practical Engineer."

Sir,—I have read the correspondence on the Steam Engines and Boilers Bill for the last few weeks, and I think if inspectors and engineers were more friendly with each other things would be much better for both parties. The question is, as far as I understand, Should enginemen hold certificates of competency, or not? Now, none of your correspondents go dead against the certificates; therefore, let us try and work together for them. I ask the question, which has been asked again and again, Why is a certificate necessary for the marine engineer, and not for the stationary engineer?—Yours truly,

June 4th. Water.

WARMING RAILWAY CARRIAGES.

To the Editor of "The Practical Engineer."

Sir,—Under this heading, in your issue of 11th May, you describe J. Langfield's method of warming railway carriages as if it were "original and novel." Both pleas fail, however, unless this gentleman can show priority to Mr. Watson's American patent for doing the same thing in precisely the same manner, for in my *Engineering Review* of 31st March, 1883 (p. 101), the following may be read: "Various means have from time to time been suggested for heating railway trains in place of the primitive one of hot water, but Mr. W. H. Watson, of North Pownal, Vermont, has patented an invention for warming railway carriages, in which he even dispenses with steam or stoves. By a special arrangement of the locomotive the cold air is taken in by the momentum of the train furnishing the necessary draught through the smoke-box, and is distributed to the cars by air-pipes. A register under each seat, under the control of the passengers, regulates the admission of heat as required," &c. To this your contemporary, *Iron*, at the time remarked: "This reads very well, but we are afraid the locomotive engineer will have to say something in the matter, and we should be very much surprised if that important personage were to approve of Mr. Watson's inventions."

The two ideas will thus be seen to be identical in principle, and will no doubt be interesting to your readers.—Yours truly,

Manchester, June 3rd, 1888. A. Tolhausen, C.E.

EFFICIENCY OF ECONOMISER.

To the Editor of "The Practical Engineer."

Sir,—I should be benefited if any of the readers of your valuable paper would favour me with a little information on the following: First—What will the saving of an economiser amount to, consisting of, say, 120 pipes, with a coal consumption of 145 tons per month? Second—I have one of Mosscrop's patent continuous speed recorders, with steam gauge attached. There is a column of water in a $\frac{3}{8}$in. pipe of 6ft. I wish to know if it (the pipe) will make any difference to the pressure on the steam gauge.—Yours, &c.,
Engineer.

Orrell, near Wigan.

WORKING OF STEAM ENGINE—IMPAIRED VACUUM.

To the Editor of "The Practical Engineer."

Sir,—We have a compound tandem engine. The diameter of the H.P. cylinder is 22in., and of the L.P. 42in.; stroke, 4ft.; revolutions, 50 per minute; steam pressure on boiler gauge being 100lb. Recently we have had our engine indicated, and the cards showed us that the pressure in the H.P. cylinder was only 70lb. The vacuum gauge showed us there was 12½lb. of vacuum in the condenser, while there was only 5lb. shown by the card of the L.P. If any of your numerous readers can let me know, through the medium of your paper, the probable cause of this vast difference between the boiler pressure and the pressure on the piston, and also the difference between the vacuum gauge and the card, I shall be most thankful.—I am, yours, &c., A Young Engineer.

COMPOUND LOCOMOTIVES.

To the Editor of "The Practical Engineer."

Sir,—As I was first to contribute to your valuable paper on compound locomotives, giving facts proving without doubt that the compounding system is superior to the ordinary locomotive, and which no one has attempted to dispute, there is nothing left for me now but to defend the system (Worsdell's) to which I referred, and of which I have a thorough practical knowledge. I was pleased to see in your last issue that "Dreadnought" acknowledged that "Worsdell's" compound locomotives would start without admitting steam into the low-pressure cylinder, and also admitted that he was not in anyway well acquainted with the system.

I thought my last paper would have convinced any unbiassed mind that coupled locomotives were in no way detrimental, provided they were built correctly. To prove my assertion, let me tell "Dreadnought" that I know of one four-wheel coupled passenger engine with 7ft. diameter wheels which ran express trains from Newcastle to Edinburgh and York for four years without being lifted—that is, no repairs were required; not even the tyres turned up. If there had been any of that spasmodic hop-step-and-jump motion on the foot plate, surely the drivers (who are ever ready to complain if there is anything amiss) would have had it into the works for repairs before half that time had expired.

Again, what about the six-wheel coupled goods engines, which are doing excellent work on every line in the world. Would "Dreadnought" advise all locomotive superintendents to disconnect the wheels and run them singly just because the wheels have to skid on going round a curve, or because there is a chance of one wheel getting less in diameter than the others by the unequal wear of the tyres? No, I am sure no locomotive superintendent would ever dream of such a thing; and if it is necessary to have six wheels coupled for goods engines to do their work, how can it be wrong to couple four wheels of a passenger engine.

Then, again, "Dreadnought" appears to ignore any skidding on going round curves, or uneven wear on tyres of single driving wheels, for he says the reverse curves will correct them. I will simply use his own argument to upset his theory on this point, that is where he states in his letter, "We will suppose a case of a four-wheel coupled engine, in which the left wheel on the driving axle and the right wheel on the trailing axle are both slightly larger than the wheels on the other and opposite sides respectively," &c., &c.—in short, he means, as I understand it, that all the four wheels are of different diameters. According to his theory, the left driving wheel, being the largest in diameter, will skid the other three wheels. This I say is impossible if the weights are equally distributed. It is more likely that the three small wheels will skid the large one until it becomes the same diameter as the others.

I contend that it is just as essential (or more so) to have both wheels of independent drivers of the same diameter as it is for the coupled engine, for if one wheel is less in diameter than the other to commence with, they will stand a far less chance of becoming equal by skidding, or even keeping the same diameter.

I think "Dreadnought" is quite as well aware as I am that no four wheels would be allowed to go under any engine, as he supposes, all of different diameters, and I am satisfied, if no other fault can be found with Worsdell's system of compounding locomotives, that it is a complete success.—Yours truly, Practical Observer.

June 4th.

QUERIES AND REPLIES.

Ewart's Chain.—I should like to know the address of the firm who make a chain called "Ewart's chain," which comes to pieces, and to which additional links can be added from time to time.—F. P. C.

Answer.—If "F. P. C." will write to the Leys Malleable Castings Company, Limited, Vulcan Ironworks, Derby, I dare say the firm, who are makers of this chain, would forward him their catalogue.

Tempering Snaps.—Which is the best method of tempering snaps for $\frac{7}{8}$in. and 1in. rivets?—Blacksmith.

Answer.—In reply to "Blacksmith's" query, my method of tempering snaps (the result of 15 years' experience) is as follows: If the snaps are made from good cast steel, when bored and turned up ready for hardening get a water tap to run steadily, with a solid stream about $\frac{3}{16}$in. or $\frac{1}{4}$in. thick; then get the snap red hot (not too hot), put it under the water and hold it level, so that the water drops in the centre and runs over the edges evenly all round. Hold it in this position till it is nearly cold, when, if the steel is good, the snap is ready for use.—J. B.

Copper Boiler.—Could any reader inform me what would be the most suitable kind of copper boiler, with fire box, for $2\frac{1}{2}$in. by $3\frac{1}{2}$in. stroke horizontal engine, to be heated by a lamp or otherwise, and what would the dimensions be?—F. W. T.

Concave Circular Saw.—Can any reader describe the use of a concave circular saw? It is supposed to be attached to the end of saw spindle outside of bench and driving pulleys.—H. C.

Humidifiers.—Will some of your readers who have practical experience with the working of "Humidifiers" in weaving sheds kindly inform me as to their effectiveness? also give maker's name and approximate cost.—D. W.

Ejector Condenser.—Can any practical reader give me any information about Morton's ejector condenser, and say if the same could be applied with advantage to a 20 h.p. portable engine, there being a plentiful supply of water just at hand, but a long way to be always hauling coal? I do repairs at a saw mill engine in the country, and thought something like the above would save much coal in twelve months. I should also like to know the probable cost and rule as to size of injection pipes.—Young Fitter.

Machine for Stamping Nails.—Will one of your readers give me the name of a good firm to manufacture a special press for stamping out nails?—F. C.

Thin Plates.—Can any of the readers of your practical and valuable paper inform me if it is possible to get thin sheets of iron or steel (say 20's gauge) as large as 8ft. 6in. by 4ft. 6in.? If so, where?—Chalkline.

Composition for Driving Ropes.—Will some reader of *The Practical Engineer* inform me what is the best material to put on cotton ropes to keep them from wearing or to polish up the grooves. The pulleys have been turned.—J. H.

TO CORRESPONDENTS.

Book on the Indicator.—Porter's book on the Indicator, the price of which, we believe, is 7s. 6d., is one of the best we know. There is also a small book by McNaught, at 1s. 6d., which is a very good one for beginners.

Strength of Materials and Machine Design.—In answer to "Inquisitive," we should think the best book for your purpose would be Unwin's "Elements of Machine Design," by Longmans, Green, and Co. Your question regarding speed of engine cannot be answered, as the data is insufficient. Under given conditions of steam pressure, cut-off, &c., the number of revolutions would depend on the load. You could increase one if you diminished the other, or *vice versâ*.

MISCELLANEA.

Saws.—Circular saws wear faster than vertical iron saws. In sawing iron-wood and teak, the iron-wood wears out a saw ten times sooner than teak.

How to Harden Cast-iron Surfaces.—The surface of cast iron can be made very hard by using the prussiate of potash, and heat and cool three or four times, using potash each time.

Fishing by the Electric Light.—Some German sea fishermen are making experiments with the electric light for night fishing. So far the results are said to have been highly satisfactory.

Electric Railways for Japan.—Japan goes ahead. The Mikado has now commissioned an engineer to visit the States to gain information, with the intention of introducing electric railways into Japan.

Dissolution of Partnership.—We are requested to state that Messrs. Goodfellow and Matthews, of Hyde, have dissolved partnership by mutual consent. The business will be carried on by Mr. Benjamin Goodfellow.

The Strike at Darlington Steelworks.—The eight hundred men who have been on strike for nearly three weeks at the Darlington Steelworks have decided to return to their employment at the old rate of wages.

Severe Punishment for Adulterating Tea.—At Moscow a merchant, who is said to be a man of great wealth, has just been sentenced to the loss of his civil rights and to banishment to Siberia for life for adulterating tea with shrubs and sand.

Lustreless Steel Surface.—A finely-polished lustreless surface can, it is said, be produced on steel by rubbing, after tempering, on a smooth iron surface with some ground oilstone, till it is perfectly smooth and even, after which it should be laid on a sheet of paper, and rubbed backwards and forwards till it acquires a fine dead polish.

New Cable between Scotland and Ireland.—A new cable is about to be laid between Scotland and Ireland. Her Majesty's ship Monarch is now in Belfast Lough with the cable on board, but the weather has been very unfavourable. The cable will be laid from Whitehead, on the county Antrim side of Belfast Lough, to Portpatrick. After the Monarch has laid the cable she will proceed to the Shetland islands.

Petroleum Fuel.—The Union Steelworks of Chicago are now using 1,000 barrels of Ohio petroleum oil per day in place of 400 tons of coal formerly used. The change in fuel dispenses with 65 labourers. The relative cost of coal and oil is not given, but at the Leland house it is said that 18 barrels of oil were used per day in place of coal, with a daily saving of $5. In the burning of brick and lime oil can be used to great advantage, and is being generally adopted.

Destroying the Rock of Inkerman.—The Russian engineers have just succeeded, after several futile attempts, in blowing up the rock of Inkerman, which threatened to crumble down on the railroad between Sebastopol and Simpheropol. The work was so successfully performed that only a small quantity of earth fell on the permanent way, and this was speedily cleared away. Henceforth the route between Sebastopol and Simpheropol is secure against all danger of this character.

The Iron Trade.—On Wednesday week the return of Mr. Edwin Waterhouse was made to the Board of Conciliation for the Manufactured Iron Trade of the North of England. The return shows some increase in the production of iron as compared with the previous return, the quantity of rails, bars, plates, and angles amounting to 50,289 tons, as against 46,740 tons in March, and 49,819 tons in the return made at the beginning of the year. The return covers the two months ending April, and shows an average net price for all these classes of iron of £4 13s. 6d., as against £4 13s. 1d. for the return ending February. There being no sliding scale in operation, wages will not be affected. The improvement in output has been in plates.

Serious Explosion at a Sheffield Steelworks.—On Wednesday week an alarming explosion occurred at the works of Messrs. William Jessop and Sons, Limited, one of the largest steel concerns in Sheffield. The explosion occurred during the casting of a large ingot in the melting furnace. The molten steel had been successfully poured into the receiving vessel, and the plug of the latter was about to be withdrawn to allow the metal to fall into the ingot mould, when the plug burst, and the whole of the metal, amounting to 17cwt., was blown in all directions. The manager, Mr. Banham, and three steelworkers, named Booker, Gregory, and King, were very seriously burnt. Considering, however, the nature of the explosion and the mass of metal blown about the furnace, it is remarkable that the results were not more serious. The cause of the bursting of the plug is unknown.

Locomotive Engineering.—High-pressure steam on rather an extensive scale is about to be tried in America. Fourteen American type engines, with 175lb. boiler pressure, are being built for the Intercolonial Railroad at the Canadian Locomotive Works, Kingston, Ontario, and four locomotives of similar dimensions are being built by Messrs. Dubs and Co., at Glasgow, Scotland. These engines will have 18 by 24 cylinders, and 62in. driving wheels, and will weigh in working order about 95,000lb. The boiler plates in the shell will be $\frac{9}{16}$in. thick, and apparently considerable pains have been taken to make the engines thoroughly substantial and durable. Both the truck and the driving wheels are of wrought iron, steel tired. The truck wheels are made by coiling a long wrought-iron bar upon itself and welding it into a disc, while the driving wheels are made of wrought-iron spokes in the style usual in this country, rim and hub being welded together. Both truck and driving wheels are made by Krupp, of Essen, Germany.

Engineering Society, King's College, London.—At a general meeting, held on Tuesday, May 29, Professor Robinson in the chair, Mr. Colvin Smith read a paper on hydraulic machinery. After a few preliminary remarks on the history of hydraulic power, the author commenced a description of the principal types of hydraulic machines. Lifts were first dealt with, and then some of the ordinary, as well as some of the most powerful, forms of hydraulic cranes were described under the heading of the application of hydraulic power to bridges. The arrangements at the Newcastle Bridge, which weighs more than 1,200 tons, were given by the author. The plant at the Forth Bridge works was chosen as a good example of hydraulic power applied to riveters, the different machines in use being described by means of diagrams. In the discussion which followed, Professor Robinson spoke of recent discoveries in connection with the flow of water in pipes and the distribution of hydraulic power in London and elsewhere. A vote of thanks was then accorded to Mr. Colvin Smith, and the meeting adjourned.

Interesting Contributions to the Whitworth Museum, Manchester.—Messrs. Sharp, Stewart, and Co., Limited, whose removal to Glasgow has been previously referred to, are gradually winding up their business in Manchester. A large portion of the machinery and tools which were formerly in use at the "Atlas" Works, in Manchester, and are not required for the new works in Scotland, are being disposed of by private treaty. Amongst them, however, are several of the early machines made by Richard Roberts, and these in their way are interesting curiosities as illustrating the primary forms of some of the best-known machine tools of the present day. It has therefore been thought desirable to preserve them as memorials of the great services rendered to mechanical engineering by one of the founders of the firm. In order that these may be suitably preserved in the district, Mr. John Robinson, the chairman of the company, has decided to present to the proposed Whitworth Museum some of the first machines made by Roberts. One of these is an old planing machine, which is believed to be one of the first, if not the very first planing machine ever made. The table of the machine is worked by a chain, and for occasional jobs it has been kept in work right up to the present. Another machine is a wheel cutter which was made by Roberts in 1820, and which, so far as its mechanical parts are concerned, presents very few features essentially different from those of modern tools. There are in the establishment several other early tools made by Roberts which are of special interest, showing that some supposed recently introduced mechanical operations are by no means such modern innovations as seem to be generally believed. Amongst these is an old milling machine, dated so far back as 1843, and which in its mechanical arrangements differs comparatively little from the modern tools of a similar type which have been introduced during the last few years.

SELECTED PATENTS.

APPLICATIONS FOR LETTERS PATENT.

May 25th.

7654 Rail Raiser, F. Bohler, Sheffield.
7655 Conductors of Electricity, R. E. B. Crompton, Chelmsford.
7656 Draught in Fire Places, A. A. Tattersall, London.
7659 Ejector Mechanism, C. O. Ellis and E. W. Wilkinson, trading as C. Osborne and Co., Birmingham.
7663 Wire Drawing Machinery, F. Smith, Manchester.
7667 Furnace Fires, B. Finch, Manchester.
7670 Machine for Sawing Stone, J. Harrison, Stockton-on-Tees.—[Complete Specification.]
7676 Oil Lamp, W. Moore, London.
7679 Electric Lamps, J. G. Sowerby and C. J. Chubb, London.
7685 Manufacture of Aluminium, W. G. Forster, London.
7686 Manufacture of Nails, H. H. Lake, Middlesex. (G. A. Cavalli, United States.)—[Complete Specification.]
7689 Blasting Charges, G. H. Greatbach and T. Crake, London.
7690 Grab Buckets, W. Pitt, London.
7692 Manufacture of Screws, C. K. Falkenstine and J. J. Varley, London.
7693 Drain Trap, C. J. E. Kinslow, London.
7696 Incandescent Safety Lamps, T, Coad, London.
7698 Gas Engines, M. Janiot, London.

May 26th.

7703 Fuses for Blasting, H. J. Warrington, Hanley.
7705 Valves, A. Bruce, Glasgow
7709 Ribbed Tubes for Boilers, W. P. Thompson, Liverpool. (J. P. Serve, France.)
7710 Heating Steam Generators, R. Shackleton, Bradford.
7711 Mechanical Stokers, A. H. Stott, Oldham.
7713 Hydrocarbon Oil Lamps, F. R. Baker, Birmingham.
7721 Revolving Shafts, T. Brook, Halifax.
7723 Screws, W. Thurman, Birmingham.
7724 Propelling Vessels, G. Chapman, Glasgow.
7727 Metallic Packing for Piston Rods, N. S. Hawks, London
7729 Steam Engines, P. Thomas, Stockton-on-Tees.
7740 Door Fastener for Railway Carriages, C. W. Spong, Surrey.
7742 Injectors, R. G. Brooke, London.
7748 An Electric Motor, L. Hoppe and G. Hoppe, London.
7750 Electric Arc Lamps, J. Dulait, London.
7752 Car Trucks, S. Davis, London.—[Complete Specification.]
7753 Cooling Bearings of Machinery, T. A. Adamson, London.
7757 Bicycles, F. Bell, London.
7758 Wagon Weighing Apparatus, C. R. Baihe, London,—[Complete Specification.]

May 28th.

7761 Method of Applying Electricity, C. B. Burdon, Cheshire.
7764 Fluid Engines, H. Robinson, Manchester.
7766 High-pressure Boilers, A. Jackson, West Hartlepool.
7767 Pumping Engines, J. Fielding, Gloucester.
7770 Ships' Steering Gear, E. J. Bean, London.
7773 Manufacture of Wrought Iron, R. R. Gubbins, London.—[Complete Specification.]
7777 Safety Lamps, G. L. Scott, London.—[Complete Specification.]
7785 Couplings, C. Lock, London.
7786 Propulsion of Boats, R. Werner, London.—[Complete Specification.]
7790 Propulsion of Ships, G. Tate, London.—[Complete Specification.]
7791 Automatic Guns, T. Nordenfelt, London.

May 29th.

7800 Wrenches, C. Stuart, Buckinghamshire.
7804 Propelling Cars by Compressed Air, W. E. Gedge, London. (The Auto-pneumatic Car Motor Co., United States.)
7805 Distribution of Electric Currents, H. J. Allison, London. (C. E. Fritts, United States.)—[Complete Specification.]
7807 Oil Tank, G. F. Gregory, London. (H. A. Hutchins, New York.)—[Complete Specification.]
7808 Bearings for Axles, B. F. Cocker, Sheffield.
7821 Couplings, W. Rose, of the firm of W. Rose and Co., and T. L. Daltry, Manchester.
7826 Galvanic Generators, H. B. Cox, London.—[Complete Specification.]
7844 Machinery for Drilling, F. Oddy, Bradford.
7845 Saw Mills, A. J. Boult, Middlesex. (W. Gowan, United States.)—[Complete Specification.]
7848 Indicators, W. P. Thompson, Liverpool. (G. Westinghouse, jun., United States.)—[Complete Specification.]
7851 Switches, W. P. Thompson, Liverpool. (G. Westinghouse, jun., United States.)—[Complete Specification.]
7853 Storage Batteries, W. P. Thompson, Liverpool. (C. D. P. Gibson, United States).—[Complete Specification.]
7857 Jacks, C. A. Day, London. (A. Warren, United States.)—[Complete Specification.]
7861 Steam Engines, Abner de H. Baker and F. P. Huyck, London.—[Complete Specification.]
7864 Valve Boss, S. P. Day, Brighton.
7876 Electric Batteries, B. Willcox, Middlesex. (B. A. Abakanowicz and Arsène d'Arsonval, France.)
7877 Fire Engines, A. F. Yarrow and J. B. Hilditch, London.

May 30th.

7886 Securing Railway Rails to Sleepers, J. M. Burke, Dublin.
7890 Anti-corrosive Enamel for Propeller and Blades, W. Scotson and J. Willis, Sheffield.
7895 Self-acting Mules, H. Whitwam, of the firm of B. and J. Whitwam and Sons, Limited, and H. Taylor, Halifax,
7901 Electro Magnets, J. J Horne, Norfolk.
7903 Rotary Engines, W. T. Sturgess and E. Towlson, London.
7908 Locking Miners' Safety Lamps, N. Needham, J. J. Needham, and J. W. Needham, Manchester.
7909 Vice, J. Parkinson, Yorkshire.—[Complete Specification.]
7914 Locks, H. L. Loffler, London.—[Complete Specification.]
7924 Electric Apparatus for Firing Mines, A. J. Boult, Middlesex. (G. Manet and C. Manet, France.)
7927 Motor Engines, W. T. Stubbs, Manchester.
7934 Gas Motor Engines, J. Southall, of the firm of Hardy and Padmore, London.—[Complete Specification.]
7935 Submarine Vessels, E. H. Tyler, London.

PUBLISHERS' ANNOUNCEMENTS.

BACK NUMBERS of "The Practical Engineer," from the commencement, can be obtained at either of our offices in London or Manchester, or by order of any Newsagent.

Vol. I. (bound), containing Nos. 1 to 44 inclusive, from March to December, 1887, price 6s. 6d., can still be obtained by order from any Newsagent, or will be forwarded, carriage paid, from either of our offices on receipt of the amount by postal order or stamps.

Numerous complaints having been made to us by Subscribers of the difficulty they experience in obtaining copies of the *Practical Engineer* in certain districts, we have to state that the Journal can be obtained by any Newsagent through the ordinary trade channels, and no difficulty should therefore exist in obtaining copies by order of any Newsagent.

For the information of the trade, we may state that copies can be obtained from either of our Offices in London or Manchester, or from any of the following wholesale houses.

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EDITORIAL NOTICES.

All communications for the Editor of this Journal should be addressed to 6, Victoria Station Approach, Manchester.

Communications intended for insertion in the current week's issue should reach us not later than Tuesday Evening.

We cannot undertake to return rejected manuscripts or drawings unless accompanied by a stamped and directed envelope.

Contributors are requested to write on one side only of the paper. Sketches should be sent on separate sheets.

TO ADVERTISERS.

Advertisements intended for insertion in the current issue should reach us on Wednesday morning at the latest.

THE
PRACTICAL ENGINEER.
JUNE 15TH, 1888.

TECHNICAL EDUCATION.

The agitation in favour of the extension of facilities for the acquirement of technical education appears to increase rather than diminish, and a most important and influential meeting for the furtherance of this object was held in London on Friday last. The meeting was presided over by the Lord Mayor, who was supported by Lord Salisbury, Earl Rosebery, Sir Lyon Playfair, Sir John Lubbock, Sir Julius Goldsmidt, Dr. Self (Master of the Cloth Workers' Co.), and some half-score members of Parliament, representing every shade of political opinion. The immediate object of the meeting was to discuss the ways and means of raising £150,000, a sum which the Charity Commissioners have agreed to supplement with an equal amount.

With the money thus raised it is proposed to establish three technical institutions in the most crowded parts of South London. The amount required is a large one, but it should not be difficult to raise in a city like London; and certainly no worthier object has presented itself for public support for some time past.

Lord Salisbury, in moving the principal resolution, which was to the effect that "the meeting pledged itself to give its hearty sympathy and support to the executive committee in their appeal to the public for the funds necessary for the establishment of the proposed institutes," spoke of the meeting as marking an era in the development of secondary education in this country; and considering the influential character of the gathering, and the deep interest displayed, the expression was not too strong. He pointed out how necessary it was, if movements of this kind were to be conducted to a successful issue, that they should have not only the goodwill of the Government but also the interest and sympathy of every class of the community. What he thought should be aimed at in such a scheme was the provision of opportunities for education, which would permit of the faculties of every man being developed in such a manner that he might become as prosperous and profitable a member of the community as possible.

Referring to what has already been done by private individuals, Lord Salisbury instanced the old Polytechnic Institute, in Regent Street, where the teaching of the more theoretical subjects was accomplished at the cost of about 2d. a day for day students and 4d. for evening students. Workshop or technical teaching was of course much more expensive, and amounted to as much as 1s. 8d. per day in the establishment referred to. Notwithstanding that, however, the experiment had been very successful.

Alluding to the depression that existed, more especially in the branches of unskilled labour, he pointed out very truly that man, as a mere owner of muscle, was being edged out of the race by a much more powerful competitor, and that as a simple agent of physical force the steam engine drove him readily out of the market; while as time went on and the forces of mechanical science were developed, its applications would become more cheap and varied, and the competition with human arms more hopeless still. There is, however, one region where the machine can never follow the human being, and that is in the domain of thought; in that man would always have a monopoly, and it is in the development of his power in this respect that openings for new paths of self-support should be sought.

In seconding the resolution, Lord Rosebery urged that in any scheme it was proposed to develop the field of commercial education should not be neglected, and that it was in consequence of our past apathy and neglect in this direction that we were being driven from many of our markets by foreign rivals. The suggestion, no doubt, is a valuable one, and in any scheme of technical education should hold a prominent place. To our mind, one of the main objections to the constant influx of foreign clerks into this country lies not so much in the fact that the element of wage competition is introduced, as in the fact that, when these immigrants have learned our methods and our markets, they very frequently either return to their own country and enter the service of firms opposed to us, or else become formidable rivals on their own account.

In the face of the prevailing differences of opinion as to what technical education should embrace, it was to be expected that some divergence of views would be expressed by the various speakers at the meeting. It is, however, we think, desirable that the scheme, whatever may be its final shape, should, as far as the methods of teaching and local application are concerned, not all be cast in one mould. It will be better that the scheme should at first be built in outline, and that it should be left for time, experience, and local exigencies and needs to fill in the details.

The main practical question for present discussion is, as we have stated, that of ways and means, and we cannot think that so noble a scheme, launched so auspiciously, will be permitted to fail through lack of funds.

The London City Companies have within recent years contributed both generously and wisely to objects similar to the one in question, and it is to be hoped they may be able to see their way to join with the Charity Commissioners in placing within the reach of the toiling masses of South London such infinite possibilities of physical recreation and mental improvement.

THE INSTITUTION OF MECHANICAL ENGINEERS.

Following the example of the two previous years, the Council of the Institution have selected one of the capitals of the United Kingdom for the place of the summer meeting. Last year Edinburgh was the favoured city, while the year before London had the choice. On the present occasion it is to be held in Dublin. An influential local committee for organising the arrangements has been formed, of which the Earl of Rosse is chairman, and an outline programme has been already drawn up and published, which promises to furnish an attractive bill of fare for the week. Amongst other places of interest which will be open to members, we notice the Great Southern Railways Locomotive Carriage and Wagon Works, the Rathmines Waterworks, Guinness's Brewery, and Harland and Wolff's Shipbuilding Works, Belfast. The reading and discussion of papers are, of course, to be blended with the usual hospitalities, while the entertainments include, amongst other good things, steamer trips in Dublin Bay and Belfast Lough. Altogether, the meeting promises to be a successful and enjoyable one.

THE IMPROVEMENT IN TRADE.

The Board of Trade returns have not for some time past presented such a cheery and encouraging aspect as those which have been published for the month of May. They have, it is true, for some time shown a steady, although a very slight increase; but the increase has not been so marked and decided for a considerable period past as that which has been recorded for the last month.

The total value of the imports for May was estimated at £30,371,000, and the exports at £19,276,000, the imports showing an increase of nearly nine per cent, and the exports of nearly seventeen per cent, as compared with the returns for the corresponding period last year. Great Britain has been buying foodstuffs as well as raw materials more largely, its large purchases implying an enhanced ability to purchase; while on the other hand it has been selling more coal, cotton goods, machinery, woollen fabrics, and other manufactures, the augmented sales bearing witness to accelerated activity at home, as well as to extended demands for British goods abroad. The excess of imports over exports is a point that is sometimes seized upon as a proof of decadence, whereas it is really a matter for congratulation, as it is not to be expected that the foreigner would part with his surplus balance of eleven millions worth of raw material to British manufacturers if Englishmen had not something else besides British wares with which to pay for it. It would not of course be fair to base a prediction of a permanent improvement in trade upon the returns of a single month; but at all events the returns are encouraging so far as they go, and we trust the present break in the cloud of commercial depression, which has hung over the country so long, may be the presage to a spell of brightness and activity.

THE RIBBLE NAVIGATION SCHEME.

The report of Mr. Abernethy, Mem. Inst. C.E., who was appointed a short time ago by the Preston Corporation, at the instance of a large body of ratepayers, to examine into the feasibility of the Preston Dock and Ribble Navigation Scheme, was submitted to the Preston Town Council on Thursday, the 7th inst. Mr. Abernethy states that after a careful survey of the estuary seaward of Lytham, and an inspection of the channel and the estuary at various states of the tide, he is of opinion that the proposed training wall from Bank Nook to the estuary, a length of one furlong five chains, is not necessary. He also considers the dock area of thirty acres, as originally proposed, amply large enough for any traffic that might be expected, and that the proposed extension is an unnecessary provision. He approves, however, of the additional depth of 2ft. 6in. over the dock sill, but thinks that in lengthening the dock it should also have been widened, so as to allow of two vessels lying alongside. Beyond the sum required to complete the works, according to Mr. Walker's tender, he estimates the cost of alterations and additions at £20,000. The estimate for the dredging between Preston and Lytham is, he thinks, sufficient, and he suggests that several items in the Parliamentary estimate for the year be postponed until the extent of traffic is determined, but would recommend the construction of a graving dock at a cost of about £35,000. The training walls and dredging operations, completed and in progress, will, he thinks, with further extensions, secure a navigable channel as far as Lytham, but, in his opinion, will have no appreciable effect beyond, and the construction of a channel here is a very difficult problem, on account of the varying character of the extensive sand banks. The Gut Channel, in the direction of which the present works extend, is, he thinks, impracticable, and he advocates dredging and the construction of training walls in the North Channel, and is of opinion that the cost of forming this channel to a depth of ten feet below the level of low-water spring tides will not exceed £300,000, in addition to the cost of any dredging already estimated for.

TRANSMISSION OF POWER.—IX.

Some further interesting particulars of actual power transmitted by the electric current were stated by Mr. W. M. Mordey in the course of a discussion upon "Improvements in Electric Lighting," which took place at a meeting of the South Wales Institute of Engineers, in July, 1886.

The first case was that of the transmission of 30 H.P. to a gold mine at the top of a hill in New Zealand, which was carried out by the agents of the Brush Corporation in that country. The mine was situated in a very inaccessible place, and the fuel was brought a distance of several miles, and taken up the hill by mules. At a distance of three miles from the mine there was a constant and ample supply of water power. A water-wheel was put down for driving the dynamos, and a No. 8—·165in. diameter, and weighing 430lb. to the mile—copper wire run across the hills to the mine, at which a Victoria motor was placed. For some months past the stamps and all the machinery at the mine had been driven by the Victoria motor, and the work was being done without any skilled electrical labour. The generator absorbed about 45 to 50 H.P., and delivered about 30 H.P. at the mine, which works out to between 65 and 70 per cent actual efficiency of transmission.

The second case was in Switzerland, where 100 H.P. was taken from a large water-wheel and 60 H.P. given out at a place four miles distant, an efficiency, therefore, of 60 per cent. In this case a conductor weighing 2,300lb. per mile was used, as low tension was adopted, but in the New Zealand case high tension was used, which gave a great advantage in first cost.

Mr. Mordey also mentioned that electrical power could be measured with the greatest accuracy and ease, even to the thousandth of a H.P., by simply putting an instrument in the circuit, or the H.P. being given out by a dynamo or into a motor could be ascertained in a couple of seconds.

The general result of the discussion was that the transmission of power by means of electricity was a proved success, and that it would have a rapid development, and that the success would be greater even than had attended its use as a lighting agent; and Mr. Walker believed that it would ultimately be adopted as a heating medium also, on account of the ease with which it could be adapted to circumstances.

THE GLASGOW EXHIBITION.

FROM OUR SPECIAL CORRESPONDENT.

(Continued from page 256.)

Amongst the many admirable pumping specialities made by the Pulsometer Engineering Company should be noticed the "Deane" pumps, of which there are several varieties adapted for special classes of work. Fig. 1 illustrates the "Deane Duplex" arrangement, in which two pumps and two cylinders are placed side by side, and connected so that the piston rod of one cylinder actuates the slide valve of its fellow, and *vice versa*. When the first pump is at the end of its stroke, the piston rod of its fellow, by a simple swinging lever, actuates the slide valve, so as to give steam to the other end of the cylinder, after which the second pump completes its own stroke and waits for the first pump, now in the course of its stroke, to give steam in a similar manner. These pumps are made in a variety of sizes, from a cylinder diameter of 3in. up to one of 14in. in diameter, and when desired are arranged to work compound and condensing. Fig. 2 shows an arrangement of the "Deane" pump, which has been designed for sinking purposes in cases where the lift of water is beyond the range of the pulsometer. This pump, which is double-acting, takes up but little room in the pit shaft, and is specially arranged for dealing with dirty water.

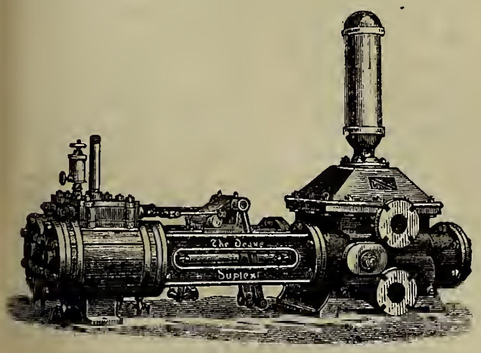

Fig. 1.

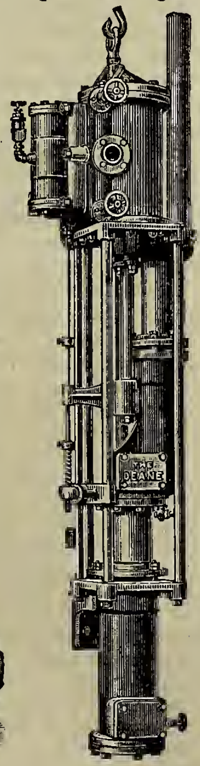

Fig. 2.

"Deane" Duplex and Sinking Pumps.

The next exhibit calling for attention is the engine shown by Messrs. Hick, Hargreaves, and Co., which is of the horizontal Corliss type, and similar in construction to the one shown at the Manchester Exhibition, of which an illustration was given in our issue for April 29th, 1887. Though the engine shown is the smallest size made of this class, it possesses all the characteristic features of the larger sizes. The H.P. and L.P. cylinders are 13in. and 42in. diameter respectively, the piston stroke being 3ft. 6in., and the engine is intended to run at about 75 revolutions per minute. The framing is exceptionally strong and neat, the one casting doing duty both as pedestal and longitudinal stay, while the end forms the cylinder cover. The cylinder is supported on brackets, and still the valves are placed two at each end, above and below, in accessible positions.

The engine is fitted with Knowles' supplementary governor for the more perfect regulation of the speed, of which the firm are the sole makers. The value of this ingenious contrivance in cases where steady running is a point of great importance, as in cotton spinning mills for instance, has been called attention to on prior occasions.

Another exhibit of this firm is Cruickshank's patent metallic packing for the glands of piston rods and valve spindles. This packing has, we understand, been largely applied and found to give excellent results. We examined this packing in one case after having been continuously at work for six years, and the wear was only $\frac{3}{16}$in. on one side and $\frac{1}{4}$in. on the other. The packing, as will be seen on a reference to Fig 3, consists of two pairs of segmental metal clips, which embrace the piston and rod or valve spindle, one pair being placed at right angles to the other, so as to break joint. The friction of the clips on the valve spindle or piston rod is regulated by small spiral springs, placed one at each corner.

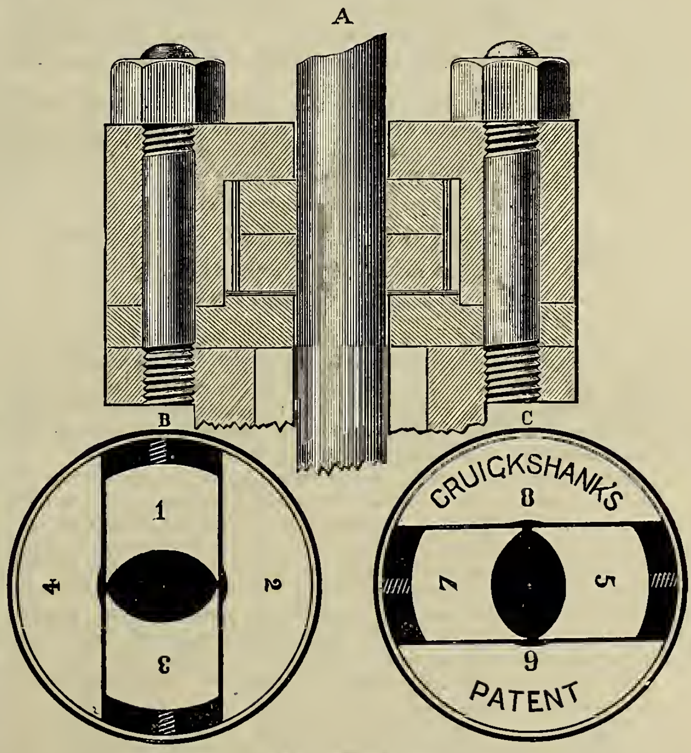

Fig. 3. Cruickshank's Metallic Packing.

Samples of ordinary rope and belt driving pulleys, for the manufacture of which the firm possess special facilities, are exhibited, though they are in the habit of making much larger ones than are shown, and, we are informed, have constructed them up to 140 tons in weight. The segments of these main rope driving pulleys are cut by special machinery on the improved arrangement of built-up wheel, while careful attention is bestowed upon the symmetrical balancing of the pulleys before leaving the works, and an apparatus is shown illustrating how exactness in this respect is ensured.

We next notice a self-oiling pedestal for line shifting, in which the oil is contained in a groove underneath the shaft, and is carried up by means of a wire ring, thus keeping up a constant supply of lubricant. At the opposite end of the bearing to which the ring is placed is a small screw for taking the oil away. There is also shown a swivel pedestal for line shafts, which adjusts itself either horizontally or vertically to any slight irregularity to which it may be subjected. Improvements in the application of this arrangement to the crank shafts of large engines have been patented, and we recently had an opportunity of inspecting samples of these bearings, which the firm are fitting to a pair of engines of 3,000 H.P., and hope in a future issue to give an illustration of the arrangement.

Reference is made in the catalogue to mechanical refrigerating machinery, but this refers to a new patent which is at present being brought out. Owing to pressure of other business, however, it was found impossible to complete the machinery in time for the opening of the Exhibition, though visitors will probably have an opportunity of seeing it later on. In this connection it may perhaps be mentioned that Messrs. Hick, Hargreaves, and Co. were the first to bring out these cold-air refrigerating machines, which, as most of our readers will be aware, have played such an important part in rendering the introduction of frozen meat from the Antipodes to the home markets a practical success.

Amongst other of the firm's exhibits which call for a passing notice is their patent automatic barring engine, which renders the position of the crank in bringing the engine to a standstill a matter of indifference, the slow, old-fashioned method of pinching the flywheel round with a hand-bar into a convenient position for starting being superseded by this little adjunct, which by an ingenious and simple arrangement is automatically disengaged as soon as the main engine is started. An illustration was given of this little speciality in our issue for May 11th. See page 222 ante.

In concluding our reference to this exhibit, it will suffice for us to say that the general excellence and finish of the work is such as might be expected from a firm of Messrs. Hick, Hargreaves, and Co.'s standing and reputation.

AN ENGINEER'S LIFE AT SEA.—VIII.

BY A SEA-GOING ENGINEER.

[Continued from page 260.]

Cleaning Boilers and Raising Steam.

On arrival at a home port it is customary to blow down the boilers and get them cold and ready for the scaling lads as soon as possible. Whenever practicable, however, the boilers should be allowed to stand a day before being emptied, and then to run into the bilges what will not flow into the dock.

Sometimes cold water is run into the boilers while they are still hot, with a view to ensure their rapid cooling, or to crack off the scale. The practice, however, is a most injurious one, and should not be resorted to except under exceptional circumstances, as it gives rise to a considerable amount of distress at the various joints and seams of rivets, resulting sooner or later in leakages, which necessitate caulking, and occasionally, serious repairs. Moreover, it is questionable whether the rapid cooling of the boiler in question does save the labour in scaling that is sometimes imagined, but the practice is certainly the more troublesome and costly in the long run.

The three most troublesome things an engineer has to contend with in the working of a marine boiler are scale, corrosion, and priming, and for the prevention of these three evils almost every imaginable nostrum has been tried, up to the mythical negro who fell asleep in the boiler and was forgotten, and whose carcase was said on the homeward run to furnish excellent results as an "anti-primer."

Happily this and the majority of other methods have few defenders now, though many, if not all, are disused chiefly on account of their cost. The tolerably uniform quality of sea-water, however, narrows the field considerably for mis-statements of utility. To prevent corrosion, zinc plates used to be frequently put in, and galvanic action relied upon. But the conditions of a boiler at work are very different from those in the well-known laboratory experiment illustrating such preservative action, and the plan is now less generally adopted. The rapid oxidation of the zinc, even when comparatively pure, affords no measure of the extent the iron has been preserved, as such action may take place even if no iron be present. It is a question also how far the substitution of the more costly zinc for the cheaper iron, plus the expense of its manufacture into a boiler, is profitable. Some engineers, however, regard reverently, and as a kind of fetish, the blackened honeycombed fragments of the metal, long after all chemical action on it has ceased. Others, again, consider that it possesses wonderful electrical properties which render it invaluable as a scale preventer and disincrustant. On sea, however, as on land, it will generally be found that an engineer's belief in the virtues of electricity is inversely proportional to his ignorance.

After the fires have been drawn and the boilers are at rest, with the pressure reduced by easing the safety valve, one tap at least on each boiler should be opened to the atmosphere, or a partial vacuum will be formed as the boiler cools. Though this may be only a few pounds per square inch, yet it reverses all the strains in the boiler, a collapsing pressure taking the place of the previous bursting pressure. This, often repeated, may in some cases be injurious, and even give rise to grooving. Owing to the usual freedom from rigidity in marine boilers, however, grooving is comparatively rare, though an instance that came under the writer's notice may be of interest. In a certain steamer both boilers gave continual trouble. The combustion chambers could not be kept tight, though they passed through the hands of several boilermakers in the course of three or four years. The three furnaces in each boiler had one combustion chamber in common, and it was found at last that this construction, which is somewhat unusual, afforded an explanation of the trouble. The lower part of combustion chambers can never be kept quite clean at sea, and owing to the wide sweep of the plate in this case, the ashes and soot would not freely run down to be drawn out by the rake through the ash-door under the bridge. This kept the heat from the plate at the bottom, and the intensity of the heat on the upper part, coupled with its unequal absorption by the bottom, and the great width of chamber, put a rocking motion on the plate at each side where stiffened by a longitudinal seam, causing grooving at the lap on the fire side, which at last became so serious as to necessitate the renewal of the plate. Owing to the wide surface of back plate also, its expansion and contraction caused the riveted stays to work about to an extent which defied all attempts to keep them tight.

In filling the boiler with water it is as well to leave the upper manhole off, so as to give ready escape for the air. If this be not done, all taps above the water level should be left open. It is usual to leave the salinometer cocks also open, so that by water running out of them the engineer may know how the filling is proceeding.

In lighting the fires it is well, if there are three furnaces, to set off the middle fire an hour or so before the others, as it is the lowest in the boiler, and thus tends to promote circulation, and prevents to a great extent the differences of temperature which might otherwise exist between the top and bottom of the boiler if all three fires were set off at the same time.

In raising steam it is usual to open the whistle cocks in the boiler as well as the one on the bridge. This not only lets the air out of the boiler, but by whistling tells when the steam is beginning to rise. These cocks on the boilers should never be shut, as it is of vital importance that the officer on deck should be able to sound the whistle at a moment's notice to avert collision. It is an easy matter, however, to forget these cocks, and the engineer should occasionally visit the top of the boilers when on watch, so as to familiarise himself with every detail. If one boiler has to be shut off for any cause, forgetting to shut its whistle cock may lead to much annoyance.

In illustration of a similar omission the following curious incident may be cited. On each boiler of the steamer in question there was a large receiver which could be shut off from the boiler by a stop valve, and from the other receiver by a stop valve situated on a short pipe attached to the side of each. The safety valves were on the main boilers. A slight repair had to be made to one receiver while the boilers lay with banked fires, and to effect this the two stop valves just mentioned were shut, the water in both boilers having previously been pumped up to the top of the glass. After a short interval both valves were opened, but presently the engineer on watch discovered that the water had nearly gone out of the glass, while, owing to the large cooling surface of the receiver being shut off, steam had risen higher than in the other boiler. The opening of the stop valves of course soon equalised this pressure, and the water was again pumped up. The repair to the receiver not being satisfactory, it was again shut off, and again opened, followed by the same disappearance of the water. But this time the fireman came to say that water was running out of the safety valves on the other boiler. Then it was remembered that a small drain pipe which led from the repaired receiver to the lower part of its boiler had not been shut, the tap, hidden away between the boilers, having been forgotten. The consequence was that the pressure of the steam forced the water up through this pipe into the receiver, to take the place of the steam condensed by cooling. On opening the stop valves the higher pressure in this boiler forced it over into the other boiler, and this being twice repeated was sufficient to fill the other boiler to the top, so that it ran out at the safety valves, which had been eased back.

In cleaning tubes at sea, some engineers call all hands, and sweep all the boxes at once. Others prefer to clean one box of tubes on each watch. Perhaps the former is preferable. Before opening a tube door, everything must be in readiness and within reach, to prevent loss of steam. In stopping leaky tubes, what are called patent stoppers are the best, and, as they are not universally known, a short description may be given. A rod, slightly longer than the tubes, has a couple of loose iron washers at each end, with a rubber washer between them. This should not be more than an inch thick, or the stopper will give trouble. These iron and rubber washers slide freely on the rod, and will also pass freely inside the boiler tube after a brush has been passed along them. The washers at the back end are separated from those at the front by a long ferrule, or by a number of short ones, so that the tightening of a nut on the screwed end of rod at front tightens both washers at once, pressing them outward against the tube. By a square which is filed on the front end of the rod, it is kept from turning when tightening the nut, and a large washer externally deflects the steam and water sideways, and acts as a hand guard for the engineer.

Occasionally, but rarely, a tube splits. One such occurred on a steamer just cast off from its moorings. The occurrence was instructive in various ways. An unusual noise in the stokehole attracted attention. The firemen were found in full retreat up the ladder, while the plates were flooded with hot water, which poured from one of the smoke boxes. The scene at once became animated. A sudden order sent the "chief" to shut off all connection between the two boilers, and to open the safety valve; and while the "second" drove the men down the ladder before him, the "chief," keeping out of the hot water by standing on lumps of coal, or whatever gave foothold, was hard at work drawing the fires, in momentary expectation of an outrush of bars and bridges, driven by the terrible steam blast from a collapsed crown. In a few minutes, however, all danger was over, and the vessel moved out of dock with only one boiler under steam.

ON BRITTLENESS INDUCED IN IRON BY PICKLING.*

THIS memoir records a long series of experiments upon the strength of wires of iron and moderately soft steel, which have been subjected to the action of water acidulated with sulphuric acid in order to remove scale from the surface. The fact that wire so heated becomes extremely brittle from the absorption of hydrogen was first published by Professor Hughes, F.R.S., in 1880, in the Proceedings of the Society of Telegraph Engineers, and subsequently in 1887 Mr. Dittmar, of Aachen, called attention to the fact that this brittleness gradually disappears when the pickled wire is left at rest for some time. The author's experiments were conducted with eight different qualities of wire, whose composition was :—

No.		C.	Si.	P.	Mn.
1.	Charcoal iron wire, unannealed	Undet.	..	0·08	..
2.	Soft ingot iron	0·06	0·08	0·16	0·18
3.	Semi-soft do........................	0·27	0·15	0·11	0·49
4.	Puddled iron wire, annealed	Undet.	..	0·07	..
5.	,, ,, semi-soft	,,	..	0·20	..
6.	Patent cast-steel wire, unannealed ..	0·43	0·01	0·03	0·25
7.	,, ,, semi-soft......	0·51	0·01	Undet.	0·20
8.	Extra tough steel wire	0·38	0·02	0·02	0·20

The wires were treated in different ways. First, by pickling in 1 per cent sulphuric acid water for twenty-four hours without previous cleaning, the tests being applied after three days; secondly, by pickling in 2½ per cent acid for twenty-three hours after cleaning the surfaces with ether, the mechanical tests being applied immediately; thirdly, by protecting the wire from direct attack by attaching a mass of zinc to one end, when a very rapid development of hydrogen takes place on the surface of the iron, which becomes brittle without being actually attacked, as previously demonstrated by Professor Hughes, and testing at once; while in a fourth series repeating the third treatment, the samples were only tested after four days' interval. The general result of these four series showed that, although the ultimate tensile strength of the wire was not diminished, but if anything slightly increased by pickling, the ductility as measured by the ultimate extension was reduced about 15 per cent, and the flexibility as indicated by the number of bends producing fracture by 39 per cent, or from 9·48 to 5·78 bends.

A fifth series of experiments showed that the original quality of the pickled wire was nearly restored by annealing it at a red heat in a current of carbonic oxide and nitrogen, the ultimate difference in ductility and flexibility between the black wire and that pickled and annealed being only 5·9 per cent in extension, and 9·8 per cent in the number of bends. Very weak acid, 1 to 200 of water, behaved similarly when the action was continued for some days, and the acid water from the Freiberg mines also had some slight effect in producing brittleness. A very decided deterioration was also produced by exposing the wires to atmosperhic oxidation for about two months, their ultimate extension and bending flexibility being reduced by about one-half in both. When, however, the freely exposed wires were protected from direct oxidation by coating the ends with zinc, only a very slight change took place in a fortnight.

The influence of time in restoring the flexibility of pickled wire was tested by allowing samples to rest in dry air for four weeks before testing, when the loss of flexibility, which was at first 76·3 per cent, diminished to about 17·5 per cent. This change was not, however, accompanied with a corresponding recovery in ductility, as in most instances the brittleness was, if anything, rather increased. Subsequent experiments made with bars of spring steel of 0·65 to 0·9 per cent carbon temper showed a loss of strength varying from 20 to 40 per cent due to pickling when subjected to a bending test. Cast iron was but very slightly affected by twenty-four hours' pickling in 2 per cent acid water; but with 8 per cent acid and nine days' exposure the transverse strength and flexibility were reduced from 11 to 19 per cent.

The author considers that the following five propositions are established by the result of the experiments :—

1. In all cases where malleable iron is exposed to influences likely to generate hydrogen upon its surface, and more particularly to the action of weak acid, a change in its mechanical properties results, the modulus of tensile strength being unaltered so long as the metal is not sensibly corroded, but the extension under stress and the capacity of resisting bending strains are notably diminished. In consequence of the changes the iron can be more easily broken, either by repeated bending or by simple bending-strains, than in the original state.

2. An action similar to that of weak acid is produced by the atmosphere when iron is exposed to it in an unprotected condition.

3. Contact of the iron with zinc, which renders the former electro-negative, has a notable effect in increasing the influence of the acid on the unprotected portion of the surface, so that a very much shorter time suffices to produce brittleness than without such contact.

4. The brittleness produced by pickling or rusting is removed by annealing, and also disappears, or is considerably diminished, by allowing the brittle metal to rest for some time in a perfectly dry place. It cannot, however, be removed by mechanical treatment in the cold.

5. Cast iron is not sensibly, or only very slightly, affected by pickling.

Finally, the author made some direct determination of the hydrogen contained in the brittle wire. For this purpose four samples of charcoal iron wire, weighing from 60 to 75 grams, were, after pickling, heated to redness in a current of nitrogen, the gas expelled was oxidised by cupric oxide, and the resulting water collected in anhydrous phosphoric acid. The results obtained were as follow:—

Wire of 2·5 millimetres.	Hydrogen	..	..	0·0021	per cent.
,, ,,	,,	..	..	0·0028	,,
,, 3 millimetres.	,,	..	..	0·0052	,,
,, ,,	,,	..	..	0·0035	,,

Although the presence of hydrogen has thus been established in the pickled wire, it seems at first sight doubtful whether such minute quantities can be sufficient to produce the very remarkable changes in the mechanical properties demonstrated by the experiments. In considering this point, the author suggests that the influence of a foreign substance upon iron may be determined not so much by the weight as by the number of atoms present, and, therefore, that hydrogen, whose atomic weight is only $\frac{1}{31}$ that of phosphorus, the element which it most nearly simulates in effect, may be sufficient to produce very decided brittleness, even when present in scarcely appreciably quantity.

H. B.

PAPER-MAKING IN CHINA.—Arrangements have been made to introduce paper-making, as at present carried on in this country, into South China. A contract for the machinery necessary to equip a mill producing 30 tons of paper weekly has been placed in the hands of Messrs. James Bertram and Son, engineers, Leith Walk Foundry, and it is proposed to erect several other mills of similar capacity under English management as soon as the first has been got to work.

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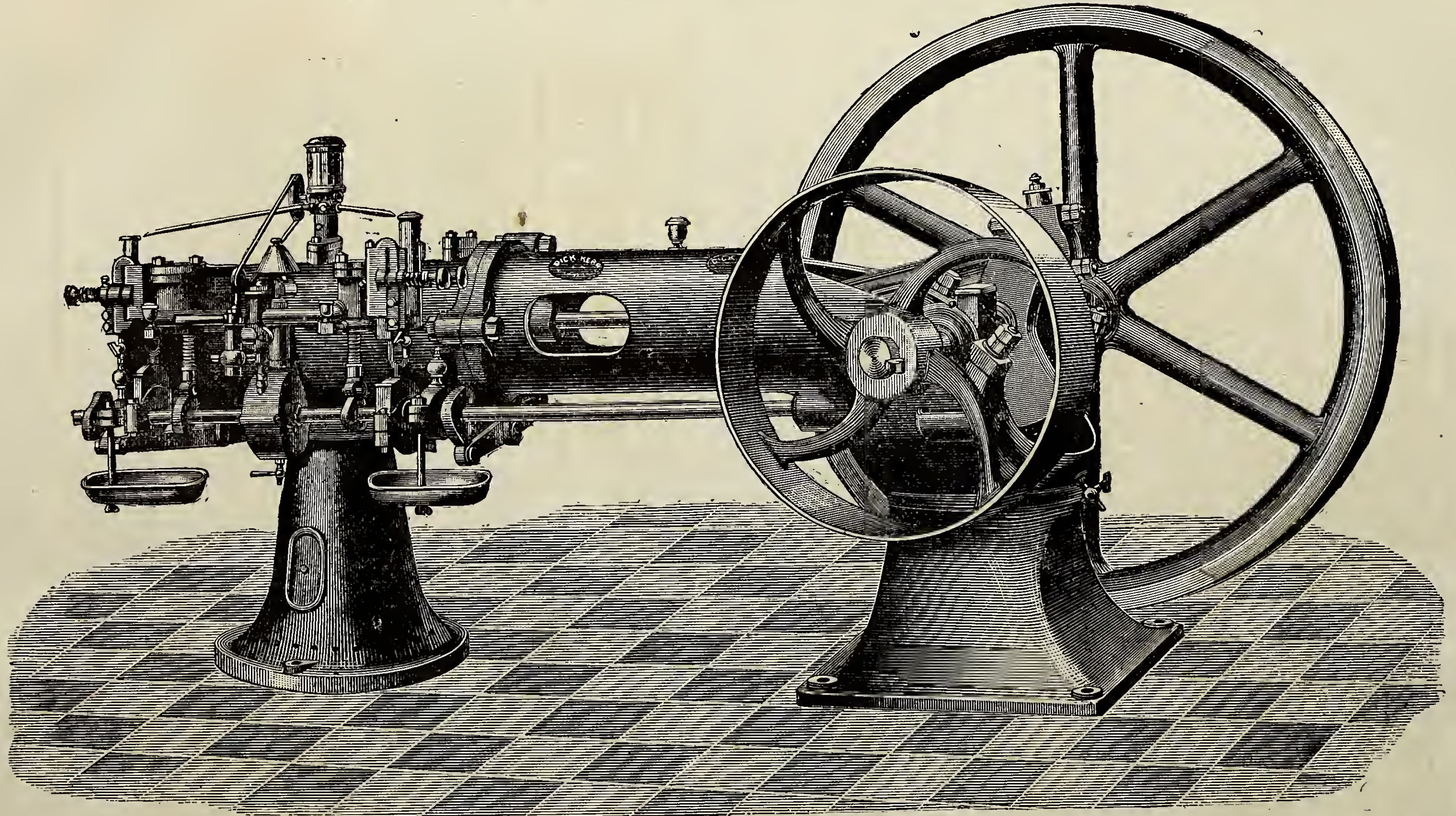
* Foreign Abstracts, Civil Engineers.

THE "GRIFFIN" DOUBLE-ACTING GAS ENGINE.



In our issue for May 4th (p. 206) we made a brief reference to a report we had just received of a test conducted by Professor Jamieson, of the West of Scotland Technical College, of a "Griffin" gas engine, and we now have pleasure in giving an illustration showing its general arrangement and construction.

The engine, in its general style and behaviour, approximates very closely to the ordinary double-acting steam engine, both ends of the cylinder being closed in, and the impulse given to the piston every one and a half revolutions—*i.e.*, combustion takes place at each end of the cylinder alternately every three revolutions of the crank shaft, when the engine is working under normal conditions. The inlet and exhaust valves are of the lifting type, actuated by a cam arrangement, which is driven by worm gear from the crank shaft.

The engine appears to be well designed for transmitting the stresses to the foundation, while the working parts are strong and simple. The one shown in the illustration is similar to that which was tested, and is designated as an 8 H.P. nominal, though during the trial it developed a brake-power of nearly double this.

For taking the pressure diagrams during the test a Richard's indicator fitted with a "sixty-fourths" spring was used, while the speed was recorded by means of one of Schaffer and Budenberg's revolution counters, which was fixed direct to the slide-valve shaft.

From Professor Jamieson's report it appears that the heat evolved by the complete combustion of one cubic foot of the gas used in the trial amounted to 534,500 ft. lbs., while the gas used per brake H.P. per hour was 24·48 cubic feet, equivalent to 534,500 × 24·48 = 13,085,000 ft. lbs.

The gas used per indicated H.P. per hour was 19·27 cubic feet, equivalent to

$$19{\cdot}27 \times 534{,}500 = 10{,}300{,}000 \text{ ft. lbs.}$$

As one H.P. per hour = 33,000 × 60
= 1,980,000 ft. lbs.,

It follows therefore that—

$$\text{Practical efficiency of engine} = \frac{1{,}980{,}000}{13{,}085{,}000} \times 100$$
$$= 15{\cdot}1 \text{ per cent.}$$

$$\text{Absolute efficiency of engine} = \frac{1{,}980{,}000}{10{,}300{,}000}$$
$$= 19{\cdot}2 \text{ per cent.}$$

From this it will be seen that the mechanical efficiency or ratio of brake H.P. to indicated H.P. was equal to 78·7 per cent, thus showing that, comparatively speaking, but a small portion of the power developed was absorbed in working the engine itself.

PICKLES' IMPROVED WOOD-WORKING MACHINERY.

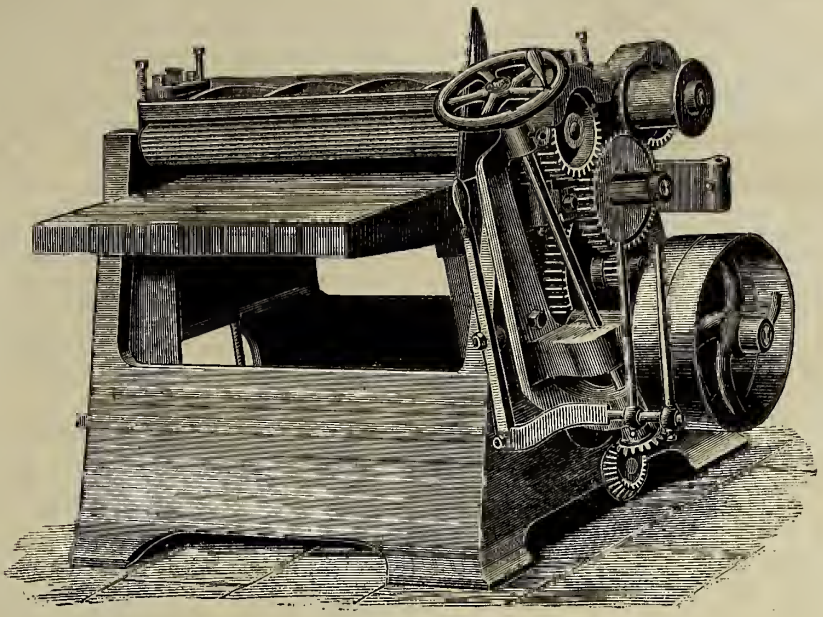


Fig. 1.

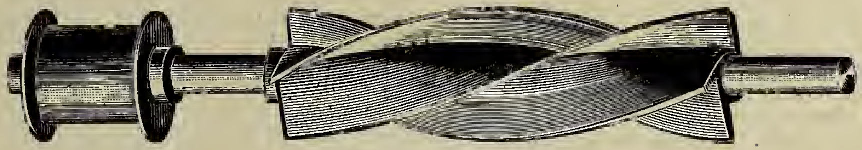


Fig. 2.

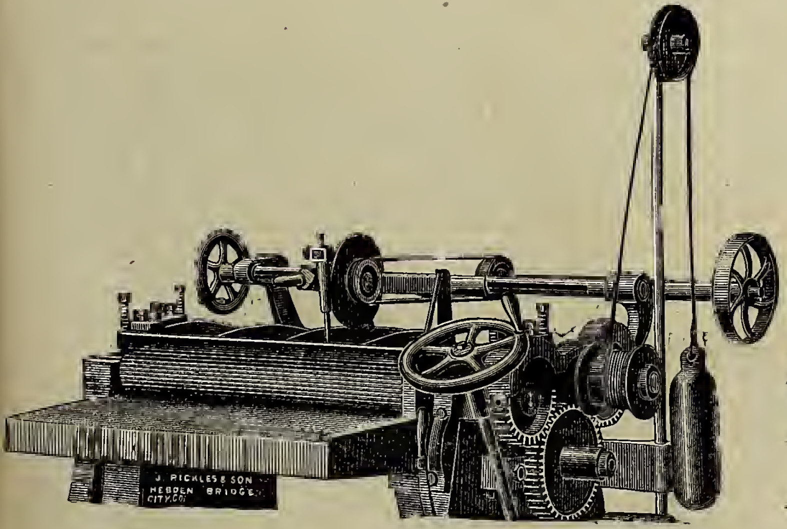


Fig. 3.

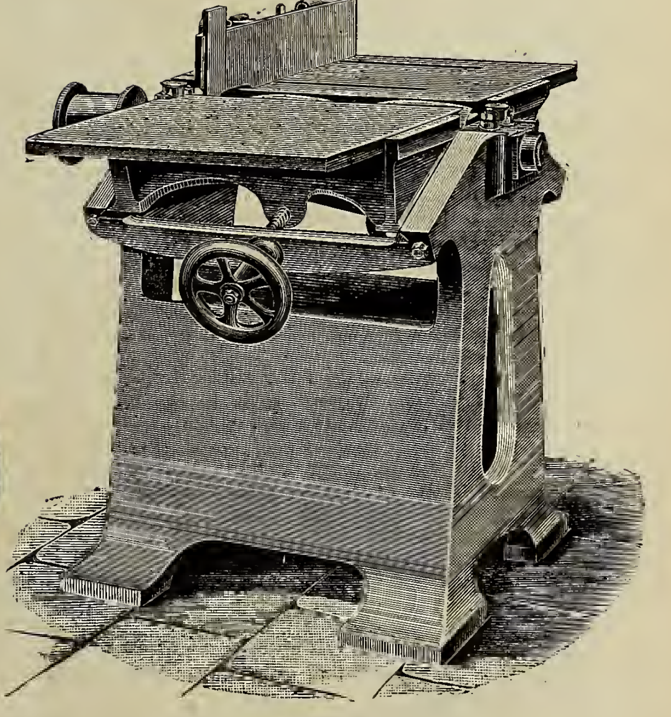


Fig. 4.

Recently we had the pleasure of seeing Messrs. John Pickles and Son's improved planing, surfacing, thicknessing, and jointing machines; and as in their construction and equipment there are some novel features, illustrated descriptions will not be devoid of interest to our readers. Fig. 1 gives a general view of the thicknessing machine, which does not require any special foundation, as the main frame is cast in one piece, is very strong, and self-contained. The feeding of the timber through the machine is effected by means of four rollers, two on each side of the cutters, the top rollers being driven, the front one being grooved. These rollers are fitted with an efficient variable spring-pressure arrangement. Between the feeding rollers and the cutter spindle pressure bars are also provided, having special mechanism for keeping in position upon the bed of the machine the timber undergoing the process of planing, &c. The bed or table, which is provided with lips over the bottom rollers to prevent the indenting of the timber a short distance from the end, is raised or lowered by means of a hand-wheel bevel and screw motion on each side of the machine, to suit the different sizes of timber to be operated upon. An index and pointer figure is provided, showing at a glance the measurement of the object passing through.

Possibly the principal novelty in Messrs. Pickles' machines is the utilisation of Rawling's patent spiral cutter, which we illustrate in fig. 2. It is a well-known fact that while machines with straight cutters are found very useful for working soft and common woods, they are sadly deficient, if not frequently entirely inefficient, when hard and gnarly or cross-grained timber has to be worked. In any case, with timber of the latter description an extra amount of hand labour is necessitated in order to obtain the necessary face and finish. To obviate and remedy the above defects various means have been adopted. Prominent amongst the devices tried is a cutter spindle presenting the cutting edge of the cutter to the wood with a little lead or shear. The cut obtained is termed a shearing cut, but practically a chopping process is the result, all the work being done by the cutter which projects most. Rawling's patent spiral cutter avoids this difficulty, and renders the planing of the most curly timber, parquetry, or other similiar difficult work in the joiner's or cabinet-maker's shop quite an easy and inexpensive process. As will be seen from fig. 2, the blades of the cutter have an angle of 20 to 30 degrees, so that it gradually enters the timber under operation, taking up a very fine shaving. When a blade has worked for about 7½in. in width, another blade commences cutting, so that with a 30in. cutter all the blades will be working at the same time. There is thus a continuous, smooth, and even process, without vibration or shock to the wood or cutter, so that the work produced is perfectly true, and without rough places or other defects.

The cutter spindle is of a square section formed out of a bar of steel, and shaped by special machinery to a spiral form. Upon each of the four sides a blade or cutter is fixed permanently, being carefully secured by screws. The blades or cutters are of a peculiar form, for the manufacture of which specially-devised plant has been put down. After the blades are attached to the spindle, they are then tempered and machined perfectly true and straight upon the spindle. The patent spiral cutter is then placed in its bearings on the machine.

In fig. 3 we illustrate an improved patent grinding apparatus which has been designed for the special purpose of producing the necessary relief of the cutting edge, and for grinding the cutters as occasion may require. This grinding apparatus can be readily secured in position upon the table of the machine by bolts, as shown in the illustration, and consists of a fine emery wheel fixed upon a sliding arm, which is manipulated backwards and forwards by means of a hand wheel and screw working in the hollow shaft. Parallel with it is a revolving shaft, upon which is a pulley (with feather key), free to move along with the sliding arm, and through a light leather belt the power is transmitted to the emery wheel. The driving pulley at the end of the shaft is so arranged that it may be driven from the same pulley which drives the cutter spindle, thus obviating the expense of an additional counter-shaft and pulleys. A steel guide is fixed close to the emery wheel, and against this guide the inside edge of the cutter is pressed by means of a weight and cord fixed on the spindle pulley. This enables the cutter to be presented in its entire length at one uniform angle to the emery wheel, and whilst the screw shown at the end of the arm regulates to the greatest nicety the process of sharpening, there is no danger of irregularity in the diameter and angle of the cutters being occasioned. There is thus an assurance that each cutter will always perform its relative amount of work.

While solidity and reliableness of construction has not been overlooked in designing this improved planing and thicknessing machine and its accessories, the question of weight has been kept well in view. The approximate weight of a machine to plane any width up to 12in. and 9in. in depth is slightly over half a ton. One to admit timber up to 3ft. in width weighs about 23cwt., but six intermediate sizes are obtainable of relative utility and weight.

In fig. 4 we illustrate one of the firm's improved surfacing machines, which is also fitted with the patent spiral cutter, as shown in fig. 2. In this machine the wood is fed over the spindle by hand, for the purpose of taking out all the twist in the board, and imparting a smooth finish to it. This surface machine will work any kind of timber, and give as good a result as the thicknessing machine illustrated in fig. 1 where an exact thickness is not required, but only a true and finished surface. It may, however, be used in conjunction with the machine already described, the board being first trued on one side in the surfacing machine, shown in fig. 4, and then passed through the thicknessing machine, which it leaves both true and parallel, and with a good finish, and where there is more work than one machine alone can accomplish such an arrangement will be found most economical. It may also be pointed out that the surfacing machine is provided with two tables, raised and lowered by hand wheel, placed one on each side of the spindle, and the *modus operandi* requires the back table to be made level with the top of the cutter, the front one being adjusted according to the amount of cut to be taken off. This machine is also provided with a canting fence, so that the edges of the boards can be planed square or to an angle.

Pressure on our space precludes a further reference at the present time to the ingenious improvements in wood-working machinery which have been successfully designed by Messrs. Pickles and Son, but in conclusion we can but testify, having seen their patent surfacing and thicknessing machines in operation, to the regularity with which the hardest and most cross-grained timber is planed by them. Parquetry, it is well known, presents unusual difficulties in the finishing process, owing to the variety of the "grains" to be dealt with, but even with it there was not the slightest trouble in obtaining a first-class and most satisfactory result.

RACK RAILWAY ON MOUNT PILATUS, SWITZERLAND.*

Amongst recent rack-lines, the railway up Mount Pilatus, on the Lake of Lucerne, is especially noticeable on account of the difficulties of the route and many novel points in constructive detail. The line commences at Alpnach, and has a total length of 2 miles 61 chains, of which 1 mile 30 chains is straight, and 1 mile 31 chains on curves of 4 to 5 chains radius. In this length the line rises 5,363 feet, the mean rise being 1 in 2·8, and the steepest 1 in 2. The summit level is 6,812 feet above the sea level. The greatest care has necessarily been bestowed upon the solid and secure formation of the permanent way. The sleepers, which are of iron, are securely bolted to two parallel longitudinal walls with granite copings. The central rack-rail is of steel, with flat top and teeth on both sides, gearing into the horizontal pinion driving wheels. The rail is in lengths of 9ft. 10in., with teeth 1⅝in. wide and 3⅜in. pitch, and is carried on a saddle-iron bolted on inverted channel-iron, which in turn is riveted by angle-iron joints on to the sleeper; the total bearing width on the sleeper, between the rivets, being 1ft. ½in. The sleepers are of rolled channel-iron, 5½in. wide and 3ft. 11¼in. long. The ordinary rails are 4¾in. high and in lengths of 19ft. 8in., and the gauge is 2ft. 7½in.

The combined locomotive and car was built at the Swiss Locomotive Works at Winterthur, the arrangement being designed to minimise the weight, which is in this case only 10 tons 6 cwt. The car portion consists of four compartments, and provides accommodation for thirty-two passengers. The width over framing is 6ft. 3in. The underframing consists of two wrought-iron girders 12in. deep, with strong transverse bracing, and the tire-wheels are 1ft. 3¾in. in diameter. The locomotive has a tubular boiler placed transversely to the axis of the line, and constructed for a normal pressure of 176lb. per square inch. It has a length of 6ft. 8in., and a heating surface of 215 square feet. The two cylinders, 8⅝in. in diameter and 11¾in. stroke, are placed outside the underframing, 3ft. 4¾in. apart centre to centre. The connecting rods work a horizontal shaft on which a small pinion wheel is cottered; and this, by a second wheel with bevel gearing, sets in motion the vertical shaft carrying the toothed driving wheels, which have a pitch-line diameter of 1ft. 4⅛in. There are fifteen teeth in each driving wheel.

The brakes are naturally of the highest importance. The two pairs of pinion wheels are generally controlled by two hand-brakes, which are sufficiently powerful to regulate the speed on the down journey as well as to stop the train. At the same time there is an atmospheric brake, similar to that in use on the Rigi line, for use on the down journeys. A reserve automatic brake is also provided, which comes into action whenever the downward speed exceeds 4·26ft. per second (about three miles per hour), and can also be worked by hand.

On account of the violent storms occasionally occurring on Mount Pilatus, it was considered advisable to fix on the framing of the car two side clamps, which underhang the rail-heads, and so prevent the wheels leaving the rails. The line was built in sections, each length being used for the transport of materials for the next length. This arrangement greatly facilitated the construction, and tested practically its working capacity.

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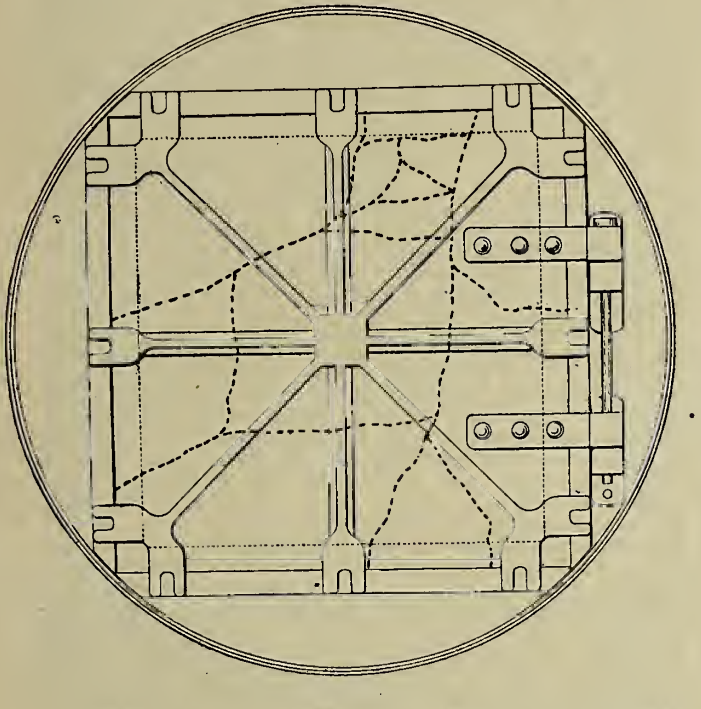
* Foreign Abstracts, Civil Engineers.

FAILURE OF THE CAST-IRON DOOR OF A STEAMING CHEST.

The objection to cast iron as a material for constructing steaming chests, kiers, &c., and the inadequacy of such vessels very often to resist the strains brought to bear upon them, have been more than once pointed out in these columns. Another illustration of this is afforded in the case of an explosion which occurred on January 2nd last, at the Amelia Street Printworks, Belfast, from the bursting of the cast-iron door of a steaming chest, and particulars of which are furnished in the report of No. 263, Preliminary Inquiry under the Boiler Explosions Act, just received.

The chest, which was a cylindrical vessel with flat ends, measured 6ft. 6in. in diameter, by 7ft. 8in. in length. The shell was made of wrought-iron plates 5/16in. thick, lap jointed and single riveted, while the front end—in which the door is placed—had four ⅜in. plates, joined together at each of the corners of the door frame, and attached to the cylindrical shell by an angle-iron ring.



The frame of the door was made of cast iron, double riveted to the front plate of the chest, while the door opening measured 4ft. square. The door which gave way was evidently intended to be ¾in. thick, but in this respect it was unequal, the thickness in some places being only 11/16in. It was stiffened with ribs inside and outside, and had a rim 3in. broad by 1½in. in thickness. See accompanying illustration, which also shows the lines of fracture.

The steam was admitted to the chest through a 2in. pipe, connected to the main boilers, which were worked at 40lb. on the inch. The chest, however, was fitted with a lever safety valve, 1¼in. diameter, which was loaded to 9lb.

The door, as will be seen from the accompanying illustration, was completely shattered; but it does not appear from the evidence that the pressure at the time was in any way abnormal. Fortunately no one was killed, but a workman who was standing near had his leg broken by one of the flying fragments.

The report attributes the explosion to the weakness of the door, and points out that with the pressure of 8lb. the door would be exposed to the load of nearly 8¼ tons, which was far too heavy for so light a structure, especially when subjected, as it must have been, to severe local strains induced by cold in frosty weather, followed by sudden heating when the chest was put to work.

The casualty emphasises the opinion we have expressed on previous occasions, viz., that in the making of such structures cast iron should, as far as possible, be avoided, and there does not appear to have been the slightest reason, except on the score of first cost, why the door in question should not have been constructed either of wrought iron or steel. Had it been, there can be no doubt the failure would not have occurred.

UTILISATION OF BASIC SLAG.

From the experiments that have been made, it would appear that the utilisation of basic slag for the purpose of fertilisation has an important future in store, and a works for the special manufacture of this artificial manure has just been started at Stillington, Durham, by the Basic Phosphates Company, Limited.

A large building, formerly used as a rolling mill, has been fitted up with five of Wood's patent mills for the grinding of hard substances, such as slag, coprolites, &c., by Messrs. Morris Brothers, Doncaster. They are similar in type to the common pug-mill, the reduction of the grist being performed by hard edge runners, revolving on a steel ring, in a large pan with a double bottom, the upper one being composed of "grids," or plates, perforated with small holes.

The slag, having been thoroughly dried over steam pipes, is fed to the heaviest mill, called the "cracker," where the large pieces are broken up, and the whole reduced to a condition resembling coarse sand, steel scrapers running round upon the "grid" throw the slag repeatedly beneath the edge runners, until it is sufficiently reduced to pass through the holes on the "grid." It is then swept into the hoppers of a small elevator, which carry it aloft and expose the half-ground slag to the exhaust of a powerful fan, which carries off all the finest particles, and deposits them in one of a series of exhaust boxes. The coarse particles fall into a receiver, which conveys them to one of the other mills, and the process continues until the slag is ground sufficiently fine to ensure its ready absorption by the soil and vegetation. The requisite fineness is found to be attained when the powdered slag will pass through a sieve containing one hundred meshes, or ten thousand holes to the square inch, and 85 to 90 per cent of the manure manufactured is guaranteed to stand this test.

Samples of the manure in bulk are frequently taken for analysis, and its constituents are found to include 45 per cent of lime, and 16 to 18 per cent of phosphoric acid. The material, when manufactured, is packed in 2cwt. bags for the home market, and in quantities of 10 kilos., &c., for the continent, whence, at present, the greater portion of the quantity manufactured is exported. As we understand, however, the price is less than half that of most phosphate manures, its more extensive adoption by the home market can only be a question of time. Meanwhile it is a matter of satisfaction to engineers to know that there is some prospect of the unsightly mounds of slag and refuse which accumulate in the neighbourhood of iron and steel works being, in cases where the basic process is adopted, put to some industrial use.

TECHNICAL EDUCATION IN AMERICA.

Referring to the importance of a sound technical education for those who propose to adopt the engineering profession, the *American Journal of Railway Appliances* states that the growth of technical schools in America is good evidence of the value of the instruction they give, and the establishment of training schools by a number of the largest railway systems is a still more conclusive proof of the efficiency of such training. Railroads have become so important a factor in our modern civilisation, that the construction, operation, and financial administration of railway systems has become a very exact and elaborate science, and there is a constant growing desire upon the part of institutions for technical instruction to meet, as far as possible, the necessity for education in this direction. There is probably no more progressive or better equipped technical school in the United States than the Massachusetts Institute of Technology, in Boston, and in that institution provision is now made for imparting a large amount of practical knowledge of railroad matters. The advanced course of study intended for students who desire to make a speciality of engineering gives extended instruction in such matters as railroad water supply, maintenance and protection, signals, brakes, and resistance of trains, time charts, arrangement of stations and yards, terminal facilities, turn-tables, round-houses, and other miscellaneous structures and buildings; tunnelling, narrow-gauge railroads, and also street railroads in their various forms of horse, electric, cable, elevated and underground railroads.

In the final year of the course, as laid down by the Massachusetts Institute of Technology, due weight is given to economic considerations, and particular efforts are made to impress upon the student the importance of a thorough study of questions of cost and economy. Especial attention is given to the economics of railroad location, including a consideration of such questions as grades, curvature, distance, rise and fall, traffic requirements, pusher grades, and balance of grades, in their effect both upon first cost and upon operating expenses. In addition to the work in the classroom, an actual railroad survey and location, several miles in length, is made each year upon such ground as shall best illustrate the actual problems occurring in practice. The application of electricity to railway working is also thoroughly treated, and students are required to attend a course of lectures devoted to this subject.

In addition to the construction of railroads, the essential principles of railway management are also covered by courses of lectures. A study is made of the subjects of gross earnings and operating expenses, and of the principal elements entering into each; of present earnings and expenses in this country in comparison with those of other countries, and in former years; and of the causes tending to produce such changes and differences which are found to occur. The course includes a discussion of the important questions of the day with regard to pools, competition and combination, State ownership and control, rates and discrimination, accidents, taxation, interstate commerce, and railroad legislation in general.

Such a course of instruction in science as that outlined above, when supplemented by the admirable courses in civil and mechanical engineering which the Massachusetts Institute of Technology affords, cannot fail to be of very material value to any young man who chooses a railway career. It is not to be believed, however, that the above or any similar course can so fully equip a man that he will be prepared to deal with any emergency of construction or adminstration, as such preparation is alone secured by experience; but the man who enters the railway service with the abundant stock of book knowledge that such a course of study can impart, is admirably fitted quickly to avail himself of the emergencies of practical railway life. Knowledge may, in a large measure, be acquired from books, but skill is to be acquired only from practical and continued application of knowledge.

A GAS LOCOMOTIVE.

The Brooklyn Annex Street Railway Company, of Brooklyn, N.Y., has been experimenting with an improved engine, on the Connelly system, with a view to adopting this motor for its lines. The machine is a combined engine and car, the former occupying the place of the forward platform. The car resembles the ordinary four-wheeled street car. The gas is obtained by an admixture of naphtha and air, in the proportion of 1 : 11; the gas is formed by passing air into a naphtha tank, and it is then compressed before being admitted to the engine cylinder, where it is exploded by an electric spark from a small dynamo. The engine shaft drives the car axle by link belting. It is estimated that the amount of naphtha used is about $\frac{1}{10}$ of a gallon per hour. The results of the experiments were very satisfactory. The company which manufactures these motors will guarantee them to make a speed of twelve miles an hour on level roads or on grades of less than 1 per cent, to ascend grades of 4 per cent when heavily loaded, and to consume not more than one gallon of naphtha when in operation. An engine on this system was operated at Coney Island, N.Y., about a year ago, but the new engine is of an improved type, and its machinery makes less noise and vibration.

CORRESPONDENCE.

We do not hold ourselves responsible for the opinions of our Correspondents.

EXPANSION GEAR.

To the Editor of "The Practical Engineer."

Sir,—In your queries and reply column of 1st of June, in reply to "Learner," "Omicron" makes a mistake as to the English makers of "Prœll's" expansion gear; it *was* Robey and Co., of Lincoln, but *is now* Marshall and Co., Gainsborough, and for Scotland, Thos. McCulloch and Sons, Kilmarnock. This correction in your next issue will much oblige.—We are, yours, &c., T. McCulloch and Sons.

THE STEAM ENGINES AND BOILERS BILL.

To the Editor of "The Practical Engineer."

Sir,—Very many letters have been written anent the above, some by those who *know*, and some by those who *think they know*—some interesting, some instructive, and some amusing. None, however, question the statements I have made and inferred in my previous letters, viz., that *skilled malice* has far more to account for than *ignorance.* Many a time in my career have I found engineers who have shown themselves anything but ignorant resort to practices that an outsider would only attribute to the grossest ignorance.

To quote cases of negligence or discrepancy on the part of inspectors scarcely tends to solve the problem; while if the inspectors began to enumerate the nefarious practices of engineers, I am inclined to think many honest and intelligent engineers would shame for their class. If there is a calling in which many are branded on account of the few, I believe it is the calling of an engineer, for it embraces a few whose sole aim appears to be to excel in mischief.

Your correspondent "Water" fully expresses my opinion with respect to the desirability of engineers and inspectors cultivating friendly relations, and there is considerable force in the following remarks which were recently made by a Manchester gentleman in a paper on "Boiler Explosions," viz., that "there is a feeling of apathy on the part of some engineers towards boiler inspection, and no matter how good the intentions of the owner may be, the action of such an individual is always embarrassing, as he withholds information which might be of the utmost importance to the insurance company in arriving at conclusions from which to offer advice to the boiler owner."

The engineer, however intelligent or skilful, can never hope to gain that extensive and varied knowledge and experience which is the possession of an old inspector. He may know far more about his own particular boilers, the boilers in a particular district, or a particular type of boiler. He may also have a special knowledge, but he cannot have that general, all-round experience which inspectors possess. Your readers may ask why. The answer is simply because where an engineer has to do with one boiler the inspector has to do with 50, perhaps 100, perhaps 1,000, and when we know that no two boilers are alike in condition, that scarcely any two sources of feed water have the same effect, or that any two types of boiler will serve the same purpose with equal efficiency, is it not correct to say that no source of information is so fruitful as that open to an inspector? With respect to the certification of engineers, I am still of opinion that it is neither for the good of the public generally, or engineers in particular, that such should be granted. A man's value would be based on his certificate, and not on his ability, and his possession of a certificate would not be a guarantee of ability. If any of your readers are desirous of possessing a certificate, let them endeavour to possess one of a voluntary character, rather than wait until such is compulsory. Certainly it will not assist them beyond being a guarantee to their employer that they know something about their business. Let our friends who advocate certification show a good front and go in unaided for the "Technological Certificate" of the City and Guilds of London Institute. They are within the reach of every intelligent engineer. I possess one in the "advanced grade," and I assure your readers I had only an elementary school education up to 25 years of age. The best advice in all the letters that have yet appeared is in "Water's" letter of this week. He asks why are certificates necessary for marine engineers? Because his position is a far more responsible one than a land engineer's. In an emergency he cannot call in a gang of engineers, but must adopt temporary means to keep the ship afloat and reach the nearest port. On the other hand, if a breakdown occurs on land, the workpeople simply go home, and if the work is beyond the "mechanics' shop," engineers are called in. The marine certificate is granted not so much for ability in engine tending as for ability to meet an emergency. Here your readers will, I think, see a difference.—Apologising for so long a letter, I am, dear sir, yours truly, Chalkline.

Manchester, June 9, 1888.

To the Editor of "The Practical Engineer."

Sir,—Having read with great interest the opinions of your various correspondents on the above subject, kindly allow me to answer the question which has been asked again and again, as per "Water," in your issue of the 8th ult. Firstly, the marine engine is generally of a much higher class than an engine of a similar size ashore. Secondly, they work under much more conflicting circumstances, viz., continuous night and day work, compactness of construction, heavy weather, &c. Thirdly, breakdowns, leaving boiler explosions out of the question, as they oftener occur from carelessness, bad design, or inattention than from ignorance. Ordinary breakdowns in a mill engine cause only a temporary stoppage, without endangering the lives of any concerned, till word is sent to the nearest machine shop, where a staff of experienced workmen and all required tools are at hand. At sea the case is quite the reverse, where no other men or tools than those on board can be obtained; besides, the stoppage, if only temporary, often places the lives, not only of the engine hands but of all on board in jeopardy, as in cases of a heavy sea, a lee shore, shifting cargo, &c.—Hoping "Water" will not again under-rate marine engineers, I am, yours, &c.,

Barrow-in-Furness, June 11, 1888. A. F.

IMPAIRED VACUUM OF COMPOUND TANDEM ENGINE.

To the Editor of "The Practical Engineer."

Sir,—Before a reply can be given to "Young Engineer" the following information is required: Is there a throttle valve actuated by the governor between the boiler and the admission valve to the cylinder, or does the governor act on the expansion cut-off valve? Does the admission valve open quickly and sufficiently at the commencement of the stroke? Are the steam ports too small, or tortuous and obstructed?

Does the exhaust valve open sufficiently wide, and continue so during the stroke? Are the exhaust ports too small, tortuous, or obstructed? Do the valves or either of the pistons leak? Each of the above things has an intimate bearing on the question asked, but no information touching any of them is given, nor even a copy of the diagrams sent, which might possibly have thrown some light on the subject.—Yours, &c.,

Cheetham, June 9th. W. A.

FAST RAILWAY TRAVELLING.

To the Editor of "The Practical Engineer."

Sir,—Under the above heading, in your last issue, I was pleased to read that the London and North-Western Railway are making arrangements to accelerate the journey from London to Glasgow by forty minutes, so as to accomplish the distance in nine hours instead of ten. This achievement leads me to ask whether the same enterprising company could not see its way to increasing the speed of the trains between London and Manchester, so as to secure an interval *en route* of from ten to fifteen minutes for refreshment without increasing the total time occupied in the journey. I think no class of men are more often called away suddenly upon business matters than such as are likely to read your paper. Manufacturing engineers are often called upon at a short notice to secure orders, while workmen are often telegraphed for to attend to repairs and breakdowns. On looking up the matter, I find I make the journey between Manchester and London about fifty times a year. The journey has often to be made by the last train in the afternoon, after a hard day's work, and I have to be prepared to begin a full day's work the next morning. Under these circumstances it frequently happens that I enter the train with but slight opportunities to prepare for a four hour's journey, and I have often met with fellow-travellers in similar plight.

I have been disappointed and annoyed several times through the train being behind time or being drawn up too far away from the refreshment room, so that it was impossible to attend to lawful needs without the danger of being left behind. If the London and North-Western Railway Company could see their way to make the experiment, by appointing one or two trains daily to stop once between Manchester and London, for not less than fifteen minutes, without increasing the total time occupied on the journey, I believe they would soon learn the importance of doing the same by all express trains. Such an arrangement would be a great boon to all passengers, but by none would it be appreciated more than by engineers, and it is in consequence of our liability as a class to be called upon to undertake long and exhausting journeys, with little or no preparation, that I venture to ask you to find space for my letter in your columns.—Yours, &c.,

Manchester, June 11th. Engineer.

COMPOUND LOCOMOTIVES.

To the Editor of "The Practical Engineer."

Sir,—If you will allow me the space in your paper for a few remarks in answer to "Practical Observer," I shall consider myself greatly indebted. Judging from his letter of the 4th inst., "Practical Observer," I am inclined to think, has not given much attention to the wording of my letter of the 29th ult., or he would have seen that the acknowledgment was a very qualified one indeed, and though not acquainted with Worsdell's system, still I have had some little experience in other engines differing in no way from that system except in cylinder sizes. I should like to know what was said in "Practical Observer's" last paper to convince unbiassed minds that coupling rods were in no way detrimental. Coupling rods, it will be noticed, is the only point in my letter that is taken notice of, to the total exclusion of the "small" matter of the turning efforts. The statement regarding the difference in wheel diameters is a fact verified by actual measurement of a 5ft. 0½in. four-coupled "mixed" engine. The total difference was $\frac{11}{32}$nds, and about equally graduated over all four wheels. As to upsetting arguments by quoting statements, how does "Practical Observer" reconcile the two following statements, viz., "It is more likely that the three small wheels will skid the large one until it becomes the same diameter as the others, and if one wheel is less in diameter than the other to commence with, they stand far less chance of becoming equal by skidding or even keeping the same diameter." The paragraph ending with the last statement and also the paragraph following seem to have been written under some misconception; in fact, the communication all through has been rather hasty. As regards drivers making complaints, they don't consider the motion is ground for complaint, never having been used to any other; and as for six-coupled goods engines, their lower speeds are in their favour to a great extent, but still the extra tractive force is only obtained at the expense of a great deal of friction, &c.—I am, yours, &c. Dreadnought.

June 11th, 1888.

To the Editor of "The Practical Engineer."

Sir,—No one appears to take up "Practical Observer" respecting compound locomotives. It would, I think, be instructive to have the matter taken up, and I may say that I know of engines on the G. W. Railway, "non-compounds," that burn much less coal per mile than any "compounds" I have heard of, and which perform their duty quite as well both with respect to speed and load.—I am, &c.,

June 9th. W. B.

QUERIES AND REPLIES.

Composition for Driving Ropes.—Will some reader of *The Practical Engineer* inform me what is the best material to put on cotton ropes to keep them from wearing or to polish up the grooves. The pulleys have been turned.—J. H.

Answer.—In answer to "J. H.," the following is a composition which I have used for many years for applying to driving ropes, both main ropes and also the small driving bands of spinning mules: Common treacle 1½lb., mutton suet ½lb., blacklead in powder ¼lb. (say crushed blacklead). Warm the treacle and mix well with the blacklead, then add the suet in a melted state, and stir till cold. A thin coat laid on the rope by hand, and well rubbed, will give good results. In the case of coarse rope a second and third coat, at intervals of a few days, will do no harm. I may say that since using the above composition the saving in ropes has amounted to 30 per cent.—J. B.

Ejector Condenser.—Can any practical reader give me any information about Morton's ejector condenser, and say if the same could be applied with advantage to a 20 H. P. portable engine, there being a plentiful supply of water just at hand, but a long way to be always hauling coal? I do repairs at a saw mill engine in the country, and thought something like the above would save much coal in twelve months. I should also like to know the probable cost and rule as to size of injection pipes.—Young Fitter.

Answer.—If you will write to Messrs. Morton and Thomson, the patentees, 96, Buchanan Street, Glasgow, for circulars, you will find these to give every information. We have had them sent to us, and we would have forwarded them to you, but you have omitted to furnish us with your postal address.—Editor.

Humidifiers.—Will some of your readers who have practical experience with the working of "Humidifiers" in weaving sheds kindly inform me as to their effectiveness? also give maker's name and approximate cost.—D. W.

Answer.—Messrs. Matthews and Yates, 35, Lever Street, Piccadilly, Manchester, are makers of "Humidifiers," and if you will communicate with them they will no doubt furnish you with every information.—J. B.

Rivet Furnace.—Can any reader of your valuable paper give me some idea of an economical rivet-heating furnace for two stationary riveting machines?—P. H.

Copper Boiler.—Could any reader inform me what would be the most suitable kind of copper boiler, with fire box, for 2½in. by 3½in. stroke horizontal engine, to be heated by a lamp or otherwise, and what would the dimensions be?—F. W. T.

Concave Circular Saw.—Can any reader describe the use of a concave circular saw? It is supposed to be attached to the end of saw spindle outside of bench and driving pulleys.—H. C.

Machine for Stamping Nails.—Will one of your readers give me the name of a good firm to manufacture a special press for stamping out nails?—F. C.

Thin Plates.—Can any of the readers of your practical and valuable paper inform me if it is possible to get thin sheets of iron or steel (say 20's gauge) as large as 8ft. 6in. by 4ft. 6in.? If so, where?—Chalkline.

TO CORRESPONDENTS.

Setting out Propeller Blade.—In answer to Mr. Sykes, we hope to give an article shortly which will afford the information sought by you and your colleagues.

G. C. B., Kilmarnock.—The field of engineering is almost boundless, and before anyone could advise you as to the best course of studies to follow to qualify you for the profession, it would be necessary for you to say what particular branch you intend to follow. There is no special designation attached to the word "civil" as applied to an engineer. It is as applicable to the man who designs an engine or boiler as to the man who maps out a canal or a railway. You do not give us your name and address, and as this sometimes causes inconvenience, we may say, for your information, as well as for that of other correspondents, that we cannot undertake to notice communications unless this is furnished.

MISCELLANEA.

A Large Gold Nugget.—The largest nugget but one ever found has been discovered by two goldseekers in the Cascade range, British Columbia. It weighs 42lb., and after being tested in every way, including boring through, it has been found to be solid and pure.

Steam Boiler Legislation.—The bill to amend the law relating to and to provide for the compulsory examination of steam boilers, which was brought into the House of Commons by Mr. Provand, Mr. Octavius Morgan, and Mr. William Abraham, and read a first time and deferred for second reading to June 5th, has been withdrawn.

Camels' Hair Belting.—According to experiments recently made at the Royal Polytechnic School at Munich, the strength of camels' hair belting reaches 6,315lb. per square inch, whilst that of ordinary belting ranges between 2,230lb. and 5,260lb. per square inch. The camels' hair belt is said to work smoothly and well, and it is unaffected by acids.

Serious Gas Explosion.—A serious explosion of gas happened at the Montreal Gasworks on the 26th ult. A leakage became ignited from a lantern which was carried into the works—an extraordinary piece of foolhardy recklessness. The building was wrecked, five persons were killed outright, five were badly hurt, and a number were injured slightly. Some painters who were at work on the roof were blown fifty feet into the air. A train on the Canadian Pacific Railway, which passes close by, rocked violently, and had a narrow escape from being overturned. The damage is roughly estimated at about £40,000.

A Powerful Tool.—The hydraulic forging press of the Atlas Works, at Sheffield, is said to be the most powerful tool ever made. It exerts a nominal pressure of 4,000 tons, but its actual maximum pressure is much greater.

Fast Ocean Steaming.—The Cunard royal mail steamer Etruria, which arrived at New York on June 2, made the passage from Roches Point to Sandy Hook Bar in 5 days 21 hours 20 minutes apparent time, or 6 days 1 hour 47 minutes corrected time, being the fastest passage as well as the fastest ocean steaming on record. The speed averaged 19·54 knots per hour throughout the entire voyage.

Ironworkers' Wages in the Midlands.—A meeting of the Midland Iron and Steel Wages Board was held at Birmingham on Monday, the 4th inst., to consider an application by the operatives of the district for an increase of 10 per cent in their wages. The application was based on the improved state of trade since the last award was made, but the manufacturers, while admitting an improvement in the demand, declined to grant the increase, contending that the prices were considerably lower than when the present rate of wages was fixed. The claim is, accordingly, left with the president of the board, Sir Thomas Martineau, for arbitration.

A New Petroleum Motor.—A prospectus has just been issued for the formation of a company to acquire and work the patents for the United States of America of Priestman's Petroleum Engine, which is actuated by common petroleum without the employment of any boiler, furnace, or chimney. The Duke of Manchester is the chairman of the provisional directors. The capital of the company is to be £150,000 in £5 shares; 10s. is to be paid on application, £2 on allotment, and the remainder on August 1st next. The estimated cost of an engine of 5 H.P. is put down at five pints per hour, which, at a cost of 5d. per gallon, works out at 3½d. per hour.

The Science and Art Department.—The expenditure for this institution now reaches nearly half a million, the largest items of which are £200,000 in direct payments for the teaching of science and art and for prizes, and £88,337 for the support of South Kensington and the Bethnal Green Museum. Of institutions supported or aided by the State through the agency of the Department of Science and Art, over £20,000 is for the purpose of the geological survey, £3,761 for the Geological Museum, England; £11,974 for the Science and Art Museum, Edinburgh; £21,972 for Ireland—the Science and Art Museum, National Library, Royal College of Science, Botanical Gardens, and Royal Hibernian Academy; and for scientific research, &c., £500.

Removing Rust from Iron.—It is often very difficult, and sometimes impossible, to remove the rust from articles made of iron. Those which are most thickly coated are most easily cleaned by being immersed in a solution, nearly saturated, of chloride of tin. The length of time they remain in this bath is determined by the thickness of the coating of rust. Generally twelve to twenty-four hours is long enough. The solution ought not to contain a greater excess of acid if the iron itself be not attacked. On taking them from the bath the articles are rinsed first in water, then in ammonia, and quickly dried. The iron when thus treated has the appearance of dull silver. A simple polishing gives it its normal appearance.

Capital Punishment by Electricity.—The Americans are nothing if not enterprising, and the latest display of their peculiar national characteristic is the adoption by the State of New York of death by electricity, in place of hanging, for capital offences. On and after January 1st next, all criminals who have incurred the extreme penalty of the law are to be done to death by dynamo instead of by rope. The change is to be accompanied with some other alteration in the mode of procedure, which has hitherto disgraced American executions, the new law enacting that the practice of allowing criminals to be visited by the public and interviewed by reporters, which has hitherto prevailed, is to be abolished, and that when the operation is performed it is to be strictly private, and of course confidential.

The Institution of Civil Engineers.—In the report of the council for the session 1887-88, submitted at the recent annual general meeting of corporate members, it was stated that during the period under review 44 members, 267 associate members, and 10 associates had been elected, and 198 students had been admitted. There were now on the books 5,530 of all classes. The receipts had amounted to £20,738 18s. 5d., while the disbursements were only £14,432 17s. 9d., more than one moiety of which had been devoted to the publications. The nominal value of the institution investments was £35,000, besides the freeholds of three contiguous houses, which had cost £40,000, the Whitworth unconditional bequest of £2,000, and trust funds investments £14,642 13s. 10d., aggregating £91,642 13s. 10d. The ballot for council resulted in the election of Mr., now Sir, George B. Bruce as president; of Sir John Coode, K.C.M.G., Mr. G. Berkley, Mr. H. Hayter, and Mr. A. Giles, M.P., as vice-presidents; and of Mr. W. Anderson, Mr. B. Baker, Mr. J. W. Barry, Sir Henry Bessemer, Mr. E. A. Cowper, Sir James N. Douglass, Sir Douglas Fox, Mr. C. Hawksley, Mr. J. Mansergh, Mr. W. H. Preece, Sir Robert Rawlinson, K.C.B., Sir Edward J. Reed, K.C.B., M.P., Mr. W. Shelford, Mr. F. C. Stileman, and Sir William Thomson as other members of council.

SELECTED PATENTS.

APPLICATIONS FOR LETTERS PATENT.

May 31st.

7941 Electro Motive Engines, H. C. B. Shalders and A. J. Thorman, London.
7945 Lubricator, G. Fairclough, Manchester.—[Complete Specification.]
7949 Pulleys. A. Higginson, Liverpool.
7950 Locks, H. Vaughan and W. H. S. Auhin, Bloxwich.
7952 Frames for Pumps, J. E. Rogers, Tipton.
7953 Supplying Water to Steam Boilers, T. H. White, and W. Hardy, Manchester.
7955 Valves for Engines, A. McGlashan, Glasgow.
7956 Springs, J. Griffin, Birmingham.
7957 Down-draught in Chimneys, J. B. Tonge, Barrow-in-Furness.—[Complete Specification.]
7964 Bearings of Vehicles, W. Thomson, London.
7967 Controlling Railway Switches, J. Drage, E. W. Verrinder, and J. P. Annett, Southampton.
7978 Engine Pistons, T. Bowen, London.
7982 Fish Joints for Railways, J. W. Armstrong, London.
7991 Starting Gear for Engines, S. W. Endicott and F. F. Ahbey, Huddersfield.
7995 Converting Iron into Steel, H. H. Lake, London. (E. Hardmeyer, H. W. Hatch, and J. C. Jackson, United States.)—[Complete Specification.]

June 1st.

8002 Ships, L. A. Groth, London. (J. F. Monnot, France.)
8009 Hydrocarbon Engines, A. S. Nolson, Glasgow.
8010 Indicators for Steam Engines, E. C. Mills, Manchester.
8013 Sewing Machines, F. F. Père, Glasgow.
8015 Bearings for Rotary Shafts, J. W. Ferguson, Keighley.
8016 Gearing and Shaft Bearings, A. Kirhy, Bedford.
8019 Speed Regulation, G. E. Sutcliffe and J. Lindley, Mirfield.
8022 Boats or Vessels, D. McIntosh Reid, London.
8028 Friction Lifts, R. Ansell, London.—[Complete Specification.]
8030 Machinery for Amalgamating Metals, F. A. Purvis, London. (W. H. Trimble, New Zealand.)
8037 Steel Socket Pipes, J. C. Johnson, Middlesex.
8039 Conversion of Electric Currents, A. Le Clercq and A. Vansteenkiste, Liverpool.
8052 Centrifugal Machines, G. F. Redfern, London, (W. P. Ahell, British Guiana.)
8055 Chain Cables, W. H. Harfield, London.
8058 Air Pump, L. Chiozza, London.
8062 Electrical Time Switch, F. Kleiner, London.
8064 Tubular Vacuum Pans, F. W. Scott, junior, London. (A. Freitag, Holland.)
8066 Caloric Engine, C. Wells, London.
8069 Bolting Machines, H. Seck, London.

June 4th.

8077 Stoves, G. Emmerechts, London.
8078 Steam Boilers, J. Watt, Liverpool.
8081 Electrical Bells, W. Rowhotham and W. Fox, Manchester.
8086 Railway Lamps, D. Ballardie, Glasgow.
8088 Rotary Motor, W. Henshall the younger, Manchester. (C. Ward, Canada.)
8095 Steel Castings, B. H. Thwaite, Liverpool.
8096 Indicator for Pumps, A. Bastow, Bradford.
8097 Stoves, D. Campbell and R. Galloway, Glasgow.
8099 Electrical Cranes, R. E. B. Crompton, J. F. Alhright, and J. H. Ferdinand, Chelmsford.
8100 Artificial Fuel, J. Bowing and E. W. Beckingsale, London.
8107 Feed-water Heaters, J. R. Scott, Newcastle-on-Tyne.
8113 Pistons, D. B. Morison, Hartlepool.
8114 Crushing and Grinding Machinery, W. D. Bohm, London.
8119 Centrifugal Pumps, C. L. Hett, London.—[Complete Specification.]
8125 Driving Bands, R. Stone, London.
8127 Condensing Apparatus, F. Vyrazil, London.—[Complete Specification.]
8128 Furnace Grates, A. H. Rohin, London.
8137 Lubricating Bearings, F. W. Durham and T. H. Shaw, London.—[Complete Specification.]
8143 Type-writing Machines, F. Myers, Liverpool.
8151 Furnace Grates, W. H. Heeson and G. H. Rogers, London.
8152 Machines for Drilling, J. H. Holman and J. M. Holman, London.
8153 Roller Bearings, L. P. Bougouin, London.
8156 Motor, Eladio Arambarri y Ostolaza, London.

June 5th.

8170 Electric Motors, H. J. Allison, London. (The Baxter Electric Manufacturing and Motor Company (Incorporated), United States.)—[Complete Specification.]
8171 Magneto-electric Indicators, J. J. Ghegan, London.—[Complete Specification.]
8176 Couplings, R. Cardwell and S. Watson, London.
8184 Making Copper Tubes, A. J. Shilton, Birmingham.
8194 Machines for Drilling, W. W. Hulse, London.
8196 Valves, J. Rigg, T. Mcacock, and A. W. C. Ward, London.—[Complete Specification.]
8200 Electrical Transformers, W. T. Goolden, and H. W. Ravenshaw, London.
8204 Cartridge Loading Machines, G. M. Peters, London.—[Complete Specification.]
8206 Cocks or Valves, E. U. Scoville, London.—[Complete Specification.]
8207 Rotary Pumps, O. Seifert, London.—[Complete Specification.]
8210 Steam Engines, A. J. Boult, Middlesex. (Vicente de Zafra Mesia, Spain.)
8211 Steam Engines, W. P. Thompson, Liverpool. (W. K. Austin, United States.)
8213 Printing Machines, J. Derriey, London.
8215 Punching Machine, P. S. Stokes, London.
8222 Designing Slide Valves of Steam Engines, W. Cooper, London.
8223 Eliminating Iron from Ores, A. H. Reed, Middlesex. (G. Conkling, United States.)—[Complete Specification.]
8228 Signals for Railways, J. Y. Johnson, Middlesex. (C. H Koyl, United States.)—[Complete Specification.]
8229 Spindles, J. A. Hart and C. Baynes, London.
8233 Cylinder Welding Apparatus, S. Pitt, London. (T. F. Rowland, W. E. Hill, and A. McLachlan, United States.)—[Complete Specification.]
8234 Welding Furnaces, S. Pitt, London. (T. F. Rowland, W. E. Hill, and A McLachlan, United States.)—[Complete Specification.]
8235 Machine Guns, T. Nordenfelt, London.

PUBLISHERS' ANNOUNCEMENTS.

BACK NUMBERS of "The Practical Engineer," from the commencement, can be obtained at either of our offices in London or Manchester, or by order of any Newsagent.

Vol. I. (bound), containing Nos. 1 to 44 inclusive, from March to December, 1887, price 6s. 6d., can still be obtained by order from any Newsagent, or will be forwarded, carriage paid, from either of our offices on receipt of the amount by postal order or stamps.

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EDITORIAL NOTICES.

All communications for the Editor of this Journal should be addressed to 6, Victoria Station Approach, Manchester.

Communications intended for insertion in the current week's issue should reach us not later than Tuesday Evening.

We cannot undertake to return rejected manuscripts or drawings unless accompanied by a stamped and directed envelope.

Contributors are requested to write on one side only of the paper. Sketches should be sent on separate sheets.

TO ADVERTISERS.

Advertisements intended for insertion in the current issue should reach us on Wednesday morning at the latest.

THE
PRACTICAL ENGINEER.
JUNE 22nd, 1888.

TRIPLE EXPANSION ON LAND.

The adoption of higher pressures and the system of expanding steam in three cylinders instead of two has proved, within the last two or three years, to be such a commercial success in marine practice, that the three-cylinder or triple-expansion engine appears destined in future designs for ocean-going steamers to supplant the two-cylinder or ordinary compound arrangement as completely as that type of engine has replaced its single-cylinder condensing rival, and the question is not infrequently asked whether a revolution of a similar character is likely to be effected amongst engines on land.

The question is an interesting and important one, especially to steam users contemplating the re-organisation of existing plant or the laying down of new. Such alterations are always more or less costly, and from the point of view of a capitalist it is much easier to make a false step in coming to a decision on such matters than it is to retrace one, and it is as annoying to discover that the saving effected by certain alterations is considerably less than could have been accomplished by the display of a little more enterprise, as it is to find out that lack of caution has involved an extra expenditure of capital without bringing any commensurate return.

Considerable misapprehension appears to prevail as to the precise reasons why triple expansion has proved so successful in marine practice, and comparisons are frequently drawn between the working of engines on sea and those on land, which, to say the least of it, are very illusory. It may be well, therefore, to point out that, before any satisfactory comparisons can be instituted, the exact conditions under which the engines work in each case require to be accurately known and carefully considered.

Primarily the economy of any steam engine, considered simply as an apparatus for the conversion of heat into work, depends on the range of temperature through which it acts; that is to say, if T be the temperature at which steam is admitted to the engine, and t the temperature at which it is rejected, then the efficiency depends simply on the range $T—t$, and the greater we can make this range the more efficient the heat-engine becomes. Now, as in actual work the lower limit, t, is practically fixed, and corresponds to the temperature of the condenser, it is evident that if an increase is to be obtained, it can only be effected by raising the initial temperature, T, or, in other words, the pressure of the steam in the boiler. Theoretically, of course, the higher the pressure the greater the efficiency. The gain, however, is by no means proportional to the increment of pressure, but decreases in a rapidly diminishing ratio; and as higher pressures involve stronger boilers and stronger engines, and at the same time introduce numerous other difficulties and sources of heat loss, it is easy to see that as a practical question the increase cannot be carried very far, and that a point is reached sooner or later at which "the game is not worth the candle," and an increase of pressure is attended with a loss instead of a gain.

So much for purely theoretical considerations. These, however, are not the only points that call for consideration in the choice of an engine, and, as every engineer knows, the type and design cannot be determined by a regard for the coal bill alone. Indeed, it often happens that other external circumstances far outweigh it in importance, and limit the choice to types which, under other conditions, would be discarded.

It happens that, in the case of large marine engines, the question of coal consumption plays a very important part in the engineer's calculations, both directly and indirectly. In the first place, the amount of power to be dealt with in the case of a large ocean-going steamer is very great, ranging from 5,000 to 8,000 I.H.P., so that any slight saving of coal measured per I.H.P. per hour amounts to a considerable sum in the aggregate, and in the case of long voyages may, in the present days of keen competition and narrow margins, make all the difference between profit and loss. This direct gain, however, does not, in the case of a steamship, represent by any means the sum total of advantage that is reaped, as in the case of a marine engine the supply of coal is, so to speak, "carried on its back," so that a saving of fuel not only means less dead load—to be devoured *en route*—but a substantial addition to the space for cargo, for which freightage is received. It is conceivable, therefore, in the case of a steamship, that it might be worth while to expend considerable efforts with a view to economise fuel, even if the space occupied by the machinery itself were not diminished. But when, by the adoption of higher pressures, the space occupied by the engines and boilers can be economised, as well as that occupied by the coal, it will be seen that the marine engineer has a treble incentive to overcome any difficulties that may attend the use of higher pressures; and it is mainly in consequence of these indirect advantages attending the saving of fuel in the case of steam engines on ships that such strenuous efforts have been directed towards this end within recent years.

Another inducement to economy in the case of marine engines is the price of the fuel itself—an item of serious consequence in the case of steamers making long ocean voyages, and put to the necessity of purchasing fuel at a high price at some distant foreign station.

On consideration, therefore, it will be seen that there are many reasons which tend to render the question of fuel economy in the case of engines on board ships a point of much greater importance, as a rule, than in the case of engines on land, and that expenditure and efforts which would be justifiable to attain this object in the former case would not be justified in the latter.

In the case of engines on land, it will be apparent that, as compared with marine engines, many of the incidental advantages accruing from economy of fuel are conspicuous by their absence, in consequence of their different environment. With engines of comparatively small power, coal at five to seven shillings a ton, and boiler and engine space of little or no value or importance, the question of coal consumption sinks in many cases from one of primary importance to one of a comparatively subordinate character, and attempts to effect economy by resorting to such expedients as forced draught and triple expansion might under such circumstances end in disappointment.

We do not, of course, contend that higher pressures and higher grades of expansion should never be adopted for land purposes, and should be sorry if a perusal of our remarks created such an impression, or prevented the engineer from resorting to such a design should circumstances be favourable, and that they may occasionally be so it is very easy to conceive. We have, in fact, a case of the kind in our mind's eye at this moment. The power required was not very large—about 300 H.P.—but space was of great value, while coal cost 35s. per ton, and no water could be obtained for condensing purposes. Under these circumstances, it was decided to adopt a boiler pressure of 160lb. on the inch, and to expand the steam in three cylinders instead of two, and the decision, we believe, was a wise one.

The conditions which prevailed, however, in this case were, it will be seen, exceptional, and quite different to the ordinary run of manufacturing establishments, where, as a rule, coal is cheap, water easy to obtain, and space of little or no value; and we very much question whether under such conditions any real advantage is to be gained by resorting to a higher pressure than 100lb. on the inch, or expanding it in more than two cylinders. With a pressure of 150lb. or 160lb., expansion in three cylinders becomes, of course, a necessity if any advantage is to be gained.

The truth is that the designing of a steam engine—we include the boiler in the term, and ought perhaps to say "power installation"—involves a number of complex considerations which vary in nearly every case. An arrangement which may be good in one case may be very ineffective in another, and the question, "What is the best type of engine and boiler to adopt?" cannot be settled by a simple reference to an abstract rule, but must be determined by a regard to the special circumstances of each particular case. To do this is the function of an engineer, and we have been led to make the foregoing remarks in the hope that steam users will be better able to realise the complexity of the problems that are frequently presented for solution, and the danger of attempting to solve them without full and careful consideration.

EMPLOYERS' LIABILITY.

During the present year the Employers' Liability Act, which was passed in 1880, expires through efflux of time, and the United Cotton Spinners' Association of Manchester have presented a petition to Parliament referring to several clauses in the bills now before Parliament for the renewal and extension of the Act in question. The petitioners view with alarm the proposed extension of the time from six weeks to three months during which notice of action by an injured workman may be given, and urge that it should not be granted, there being no good reason for the extension proposed, as it would be used rather as a rod by the unscrupulous than as a protection in *bonâ-fide* cases. Secondly, the petition regards as unjust the extension of the liability to injuries arising out of the acts of sub-contractors and persons in the employ of sub-contractors. Further, the petitioners object to the proposed extension of the limit of liability to three years' wages, or £150, whichever may be the larger sum, and urge that the limit fixed in the present Act, while substantially fair to the workman, is sufficiently onerous as bearing upon the employer. They also pray that a right of appeal should be allowed by the judge in county courts, on grounds he may deem sufficient, especially having regard to the fact that the recovery of damages and costs against the employer is always secure, while the knowledge that he cannot recover against the workman would prevent the employer making frivolous appeals.

THE TREVETHICK MEMORIAL.

The memorial window which has been placed in Westminster Abbey in honour of Richard Trevethick, the Cornish engineer, is now completed. The window is situated in the north aisle of the nave, and next to that in memory of Brunel. It consists of two finely-proportioned lancets, with a quatrefoil-shaped piece of tracery above. In the painted glass eight figures of early Cornish saints are represented, standing in two tiers of canopied niches, the name of each figure being written on a scroll beneath. A third row of niches below has figures of angels holding on scrolls outline drawings of some of Trevethick's inventions—namely, the locomotive which ran on the experimental railway in 1803, the locomotive of 1808, the steam dredger patented in 1803, and a Cornish engine and boiler. A figure of the Archangel Michael is placed in the piece of tracery, and in the canopies at the head of the lights are shields, with the arms of the See and Duchy of Cornwall.

At a meeting of subscribers, held at the Abbey, by permission of the Dean and Chapter of Westminster, to inspect the window, Sir George Bruce, President of the Institution of Civil Engineers, after thanking the Dean for his kindly interest in the movement, said that the proposal for a memorial to Trevethick originated in a feeling, very general among engineers, that his name ought to be lifted out of the oblivion in which it had lain during the fifty-five years since the great engineer's death. Trevethick had died absolutely penniless, and had been buried by the kindly charity of those who had known him best. The mark of deepest effect which Trevethick had made upon the engineering world was the introduction and application of high-pressure steam. He had begun very early with the idea of applying a pressure of 150lb. per square inch, a plan which had only very recently been introduced into ocean steamboats. Moreover, Trevethick was undoubtedly the first man to make a locomotive to run on rails or common roads; he invented the dredging machine so much employed in our rivers and harbours; he had made improvements in the form and make of boilers absolutely necessary for bringing to anything like perfection the engineering appliances in the use of steam. He seemed, in fact, to possess a marvellous instinct which enabled him to foreshadow almost all that was to be done in engineering from his day down to the present, and had, for instance, actually patented the application of the screw instead of paddles for driving steamboats.

THE JOINT STOCK COMPANIES ACTS.

That frauds of a very gross and flagrant character are frequently palmed off upon the public under the guise of limited liability companies few people who have had experience in the working of the Joint Stock Companies Acts will deny, and it is very desirable that the Acts in question shall be so amended as to prevent the rascals who systematically prey upon the public under cover of its provisions from slipping so readily through its legal meshes. A bill with this object was introduced by the Lord Chancellor into the House of Lords and read a first time on Tuesday, the 14th inst. One of the principal modifications it is proposed to introduce in the Acts is a system of provisional registration, which will impose on those who initiate companies the necessity of taking on themselves the responsibility which they now too often thrust on other people, and which will secure some guarantee that the companies have some basis of solid foundation as evinced by the best test which can be applied, viz., that there shall be a certain amount of capital actually in hand, and that those persons who promote the company shall be made responsible. One of the great sources of fraud committed by persons who get up companies is in floating old concerns with worn-out machinery, which is palmed off upon unsuspecting shareholders as new. With a view to check such proceedings, it is suggested that it should be compulsory on the companies to furnish a balance sheet, and from time to time a revaluation of the assets, which shall be satisfactory to the Board of Trade. Lord Herschell, in criticising the bill, thought it was impossible to frame any measure which skilled malice could not more or less circumvent, and it was very desirable that any alterations in the law should not be of such a character as to raise obstacles to enterprise. With this laudable desire we heartily concur; but at the same time we are strongly of opinion that the present law requires amendment, and if some clever rascals manage for a time to evade its toils, that is no reason why the net should not be set to catch them.

A Fireproof Paper.—A paper that resists the action of both fire and water has, it is said, been recently invented in Germany by Herr Ladowigg. The manufacture is accomplished by mixing 25 parts of asbestos fibre with from 25 to 30 parts of aluminum sulphate, and the mixture is moistened by chloride of zinc and thoroughly washed in water. It is then treated with a solution of one part of resin-soap in from 8 to 10 parts of a solution of pure aluminum sulphate, after which it is manufactured into paper like ordinary pulp.

THE MATERIALS OF ENGINEERING.—I.

Introduction.

The student of engineering very early learns to modify his first crude ideas respecting the characteristics of materials. We commonly speak of substances as being hard, rigid, unyielding, or soft and elastic. But on strict investigation these terms are found to have only a relative meaning, since the hardest and most rigid materials are found, when subject to certain and sufficient conditions of pressure or coercion, to behave in a similar manner to those which are yielding and plastic in character. It is very interesting to study the behaviour of such materials as iron, steel, and copper, under conditions of stress and strain, and to observe their special adaptations in the science of engineering; and in these papers it is proposed to describe in as simple and clear a manner as possible the qualities, characteristics, behaviour, and uses of the materials of engineering, treating the subject in an entirely practical manner. It will be well, in this first article, to prepare the way by explaining briefly a few fundamental terms, and pointing out a few of those facts of which we shall have to make frequent use as we go on.

Bars, beams, and structures are put into conditions of stress and strain by the load imposed upon them. The *load* denotes not only the aggregate of the external forces, but the weight of the structure itself, which may be very considerable. *Stress* signifies the internal or molecular forces, or resistances set up in the material in opposition to the external forces acting upon it. *Strain* denotes the change of form produced by the action of the load. For every stress there is a corresponding strain. If bodies were not *elastic*, this could not be the case. Not only all elastic materials, but all the so-called rigid materials, are elastic; that is, after being strained with a definite load, which varies widely for different bodies—indiarubber and iron for example—the material will, on the removal of the load, return to its original length. Up to this definite load stresses and strain are proportional to each other. But beyond this *limit of elasticity* stresses and strains do not correspond, but the strains increase more rapidly than the stresses. The limit of elasticity is the *dangerous limit*. Beyond that limit a bar will not entirely return to its original length, but will remain deflected, or extended to a certain extent, having taken a condition of *permanent set*. In other words, a physical change has taken place in the material of the bar, the molecules probably having undergone some re-arrangement.

The straining forces which produce permanent set vary in their nature. These forces are divisible into two classes, termed respectively *dead* or *statical loads*, which are loads unalterable in amount or in intensity; and *live* or *variable loads*, which are intermittent in amount and irregular in action. The former exercises a much less injurious effect upon a bar or structure than the latter, and a smaller *factor of safety* is allowable. In the latter, again, a higher factor of safety is necessary when the stresses are of two kinds—that is, *tensile* and *compressive* alternately—than when they are of one kind only; and the greater the range of stress the larger the factor of safety requisite. Practically, the amount of work which can be safely imposed upon a structure is determined by the ultimate or breaking strength, at which the elastic limit has been long passed. Having determined the *ultimate strength* by suitable tests, some appropriate factor of safety is chosen, and the ultimate strength divided by this gives the *safe working load;* or the elastic limit may be divided by a factor of safety. The reason why such factors are selected lies in the non-uniform quality of materials and the variation in loading to which structures are subjected. There is also wear and tear, the corrosion, abrasion, or other degenerating agencies to which structures are subjected. Bad workmanship also counts. Hence, when we consider the perils which depend on the yielding of a structure, we cannot too strongly insist on the need of employing factors sufficiently high to cover all the possible risks which human foresight and technical and practical experience are able to take account of. These are, for the most part, empirical, based on the practice of increasing strength where structures have been found to fail. They will range from, perhaps, three, in works in iron, subject to dead loads only, to ten, in the same material subject to live loads, and twenty or more, in masonry.

Even where a bar or structure is not strained beyond the elastic limit, there follows on the often-repeated action of live loads a certain degeneration of material, so that a load which has been repeatedly and safely carried, will ultimately cause fracture. This condition is termed, for want of a better name, *fatigue* of the material, and it signifies that some molecular change has taken place therein, by reason of which its elastic property and its tenacity have been diminished.

All strains may be resolved into the two fundamental kinds, *tensile* and *compressive*, or pulling and crushing. A *transverse* strain is a combination of the two; *torsion* and *shearing* are essentially tensile actions.

J. H.

(To be continued.)

THE NORDENFELT TORPEDO.

An interesting and successful trial of the Nordenfelt electrically controlled torpedo took place in the Thames at Erith, on Friday afternoon, in the presence of a large company of British and foreign naval and military officers. The torpedo, which embodies all Mr. Nordenfelt's latest improvements, is of large size, measuring 35ft. long with a *maximum* diameter of 29in. Its total weight charged for action is 6,200lb., the charge consisting of 300lb. of explosive, but this can be increased to 500lb. The torpedo is self-contained—that is to say, it carries within itself its motive power, which is electricity, its propelling, steering, and manœuvring apparatus, its cable, which is paid out as it travels, and its charge. It is cigar-shaped, and when moving in the water, which it does at about 6ft. below surface, nothing is seen of it but a couple of floats whereby its position is indicated to those who are controlling its movements. It carries 120 storage cells, developing 18 H.P. The motor weighs 780lb., and is driven at 1,100 revolutions per minute. The electric cable is three-cord and 3,000 yards long, but 4,000 yards or even more can be carried. The weapon is driven by a screw propeller and steered by a balanced rudder, the speed being 14½ knots.

The advantage this weapon is stated to possess over most other controlled torpedoes is that when once charged it does not require a prepared base to operate from, but may be taken anywhere. It may be towed out by a small boat to any required position, started and steered so as to strike any vessel within its range, which latter simply depends upon the length of the electric cable carried by the torpedo. When once charged it is ready for use, and will remain so for a very long period without recharging. The present torpedo is intended for harbour and coast defence, and at the trial on Friday it was started from an old vessel as a platform, from the deck of which it was operated by a keyboard. Some distance from the platform a pair of red flags were flying on two poles placed 50ft. apart, aud about half a mile lower down the river were two more flags similarly placed. The torpedo was started and passed centrally between the first pair of flags, continuing onwards at an estimated speed of 14 knots to the second pair, between which it passed in perfect central line, and beyond which it ran for some distance. It was then stopped and reversed, and a similar run back was made in excellent style and at a good speed. A third run out was made with similar results, the torpedo having travelled nearly two miles, thus exhausting her cable. It had been intended to show the manœuvring powers of the weapon, but owing to the proximity of several moored vessels and the frequent passing of others it was not possible to carry out this part of the programme. Sufficient, however, was shown to demonstrate the running powers of the torpedo and the perfect control of the operator over it, the results being considered by those present to be highly successful. Mr. Nordenfelt, we understand, has in hand another of these torpedoes which will carry 180 storage cells, developing 34 H.P. and giving a speed of 16 knots at 1,500 revolutions per minute.

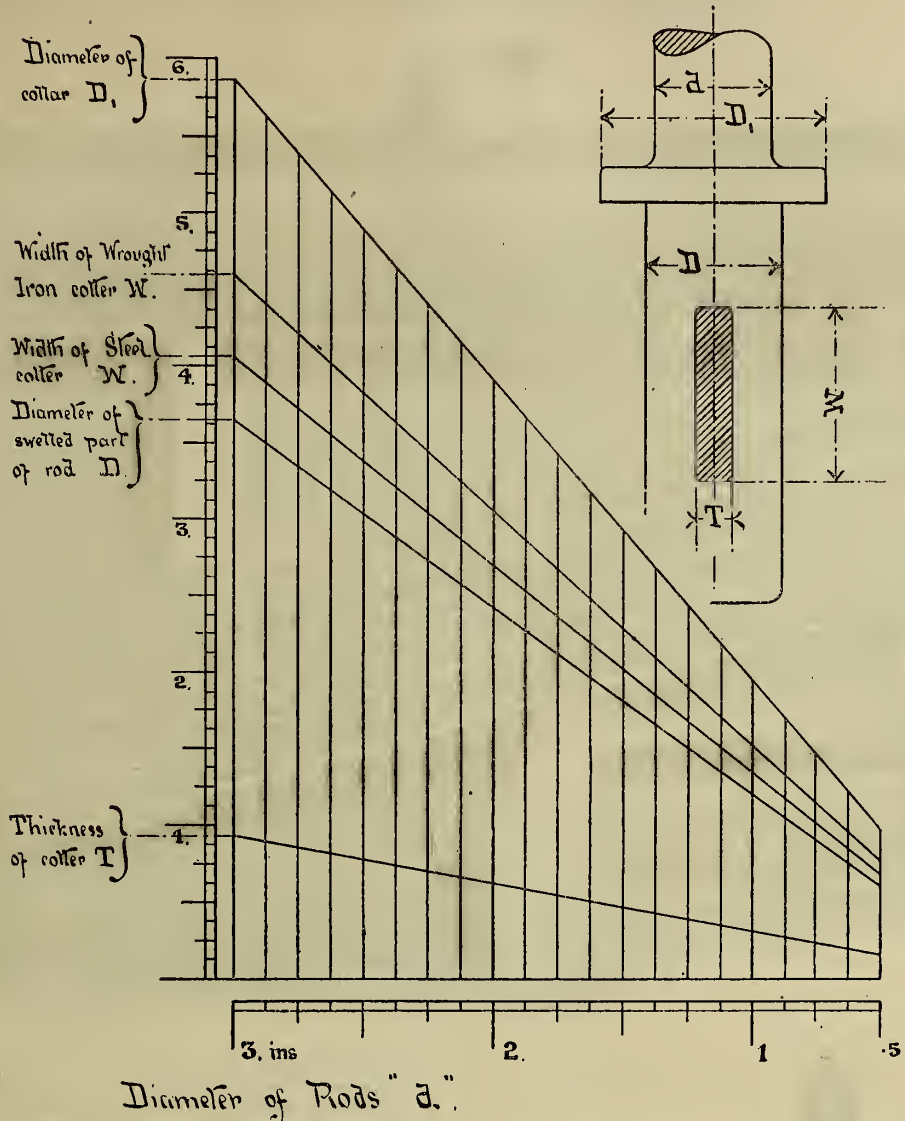
THE DISTRIBUTION OF HYDRAULIC POWER.

At the ordinary meeting of the Institute of Civil Engineers, on Tuesday, the 24th of April, the president, Mr. Bruce, being in the chair, a paper was read on "The Distribution of Hydraulic Power in London," by Mr. Ed. Bayzand Ellington, M.Inst.C.E.

The author observed that water power was no new force, but that, as formerly understood, it was limited in its application to systems of mechanism suitable for the low pressures found in nature. The effects obtained by the use of high pressure were so different in degree from all previous experience that a new name was needed, and had been found in the term "Hydraulic Power." Bramah's genius produced the hydraulic press, and he clearly foresaw the future development and great capabilities of his system; but it was reserved for Lord Armstrong to work out and superintend the intricate details that had to be developed before the system could be made fully serviceable. The public supply of hydraulic power in London constituted the latest development of this system. The hydraulic power was supplied through mains charged by pumping at a pressure of 700lb. per square inch. The first and largest pumping station had been erected on a site known as Falcon Wharf, about 200 yards east of Blackfriars Bridge. The engine-house at present contained four sets of pumping engines, each set being capable of exerting 200 indicated H.P. The engines were vertical-compound, of a type comprising the advantages of a three-throw pump with direct connection between the pump plungers and the steam pistons. Each set of engines would deliver 240 gallons of water per minute into the accumulators, at 750lb. pressure per square inch, at a piston speed of 200ft. per minute. This was the normal speed of working, but when required they could be worked at 250ft. per minute, the maximum delivery being 300 gallons per minute. The condensing water was obtained from storage tanks over the engine-house, and was returned by circulating pumps to one or other of these tanks. The water delivered into the mains was maintained all the year round at temperatures of between 60 deg. and 85 deg. The boilers were of the double-flued Lancashire type, and were made of steel. All were fitted with Vicars' mechanical stokers. At the back of the boilers was a Green's economiser, consisting of ninety-six tubes. The economiser and the stoker-gear and worm were driven by a Brotherhood three-cylinder hydraulic engine. The reservoir of power cousisted of accumulators. The accumulators at the pumping station were two in number, each having a ram 20ft. in diameter and of 23ft. stroke. The weight-cases were of wrought iron, and were filled with iron slag. The total weight of the case and load on each ram was approximately 106 tons, corresponding to a pressure of 750lb. per square inch. The storage tanks formed the roofs for the engine and boiler houses. The water for the power supply was obtained from the River Thames, and was pumped into the tank over the engines. The water passed through the filtering apparatus by gravity into the filtered water tank over the boiler-house, which was 7ft. below the level of the unfiltered water tank. The filters consisted of cast-iron cylinders, and each contained a movable perforated piston and a perforated diaphragm, between which was introduced a quantity of broken sponge; the sponge was compressed by means of hydraulic pressure from the mains. The delivery of power water from the Falcon Wharf pumping station was through four 6in. mains. The most distant point of the mains from the accumulators was at the west end of Victoria Street, and was 5,320 yards, or just over three miles. To provide for all frictional loss in the pipes and valves, the accumulators had been loaded to 750lb., the stated pressure supplied being 700lb. per square inch. The total length of the mains at present laid was nearly 27 miles. The mains were laid in circuit, and there were stop-valves at about every 400 yards, so that any such section of main could be isolated. The method employed for detecting leakage was based upon an automatic record of the number of gallons delivered into the mains, and in cases of abnormal increase during the night, if found to arise during the early hours of the morning, the mains were tested. The power water used was invariably registered through meters on the exhaust pipes from the machines, and from the meters passed to the drains. There was a sliding scale of charges from 8s. to 2s. per 1,000 gallons at 700lb. pressure per square inch, designed to meet, as nearly as possible, the variable conditions and requirements of consumers. The more continuous the use, the lower the charges. The scale was intended chiefly for intermittently-acting machinery, and experience had fully proved that these rates were sufficiently low to effect a large saving to the consumer in almost all cases, whether for a large or a small plant. The author believed any idea of supplying power from a central source, at rates much below these, to be chimerical. The practical efficiency of the hydraulic system might be fixed at from 50 to 60 per cent of the power developed at the central station.

In addition to the general supply of hydraulic power in the city and adjoining districts, a new departure has been taken by the application of hydraulic power to an estate at Kensington Court. Seventy houses and dwellings were to be built on this estate, of which thirty had been already erected. Each house was fitted with a hydraulic lift, taking the place of a back staircase, and the power supply was provided on the estate expressly for working these lifts. The driven machinery was of great importance to an economical and satisfactory result as the distributing plant, but this obvious fact was not always understood. In London more lifts were working from the mains, and more power was used by them, than by any other description of machinery. The number of all classes at present at work was over four hundred. The principal types in

PROPORTIONS OF COTTARS.



use were fully described. In some cases there had been, by adopting the public supply, a saving in the cost of working of about 30 per cent, as compared with the steam pumping plant previously in use. Lifts are now becoming so general, and the number of persons who used them was so great, that the author considered it necessary to urge the importance of securing the greatest possible safety in their construction by general adoption of the simple ram.

The next largest use of the power was for working hydraulic cranes and hoists of various kinds along the river side and in the city warehouses. It often happened that the pressure in the power mains was not sufficient for pressing purposes. The apparatus known as an intensifier was then used, by which any pressure required could be obtained.

Mr. Greathead's injector-hydrant, made at the Elswick Works, had been in use to a limited extent in London in connection with the power mains. A small jet of high-pressure water, injected into a larger jet from the waterworks mains, intensified the pressure of the latter in the delivery hose, and also increased the quantity. By this means, a jet of great power could be obtained at the top of the highest building without the intervention of fire engines. This apparatus enabled the hydraulic power supply to act as a continuous fire engine wherever the mains were laid, and was capable of rendering the greatest assistance in the extinction of fire. The number of machines under contract to be supplied with power was sufficient, with a suitable reserve, to absorb the full capacity of the station at Falcon Wharf, and another station of about equal capacity was now in course of erection at Millbank Street, Westminster.

PROPORTIONS OF COTTARS.

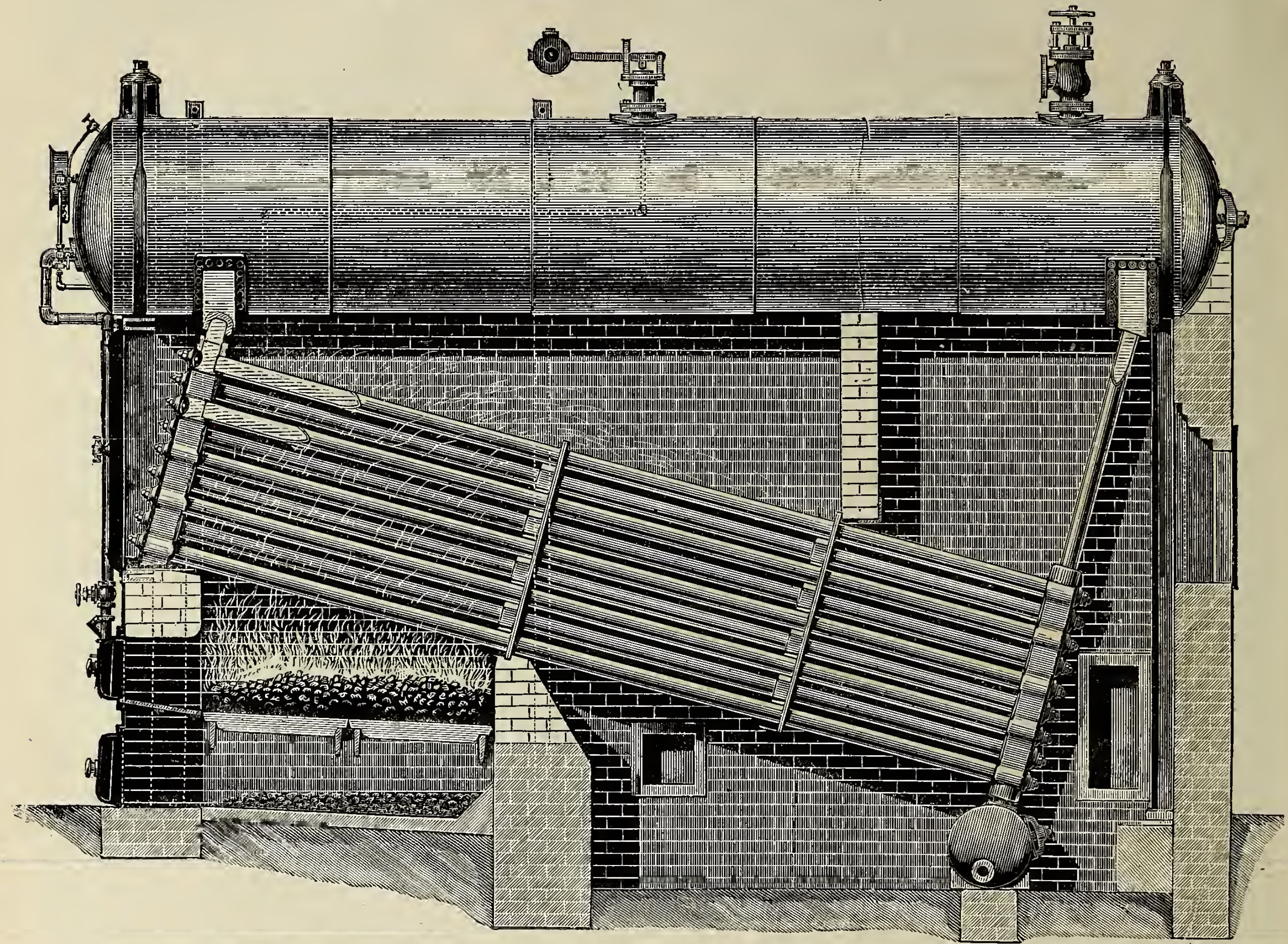
The diagram herewith, giving the dimensions of cottars through rods up to 3in. in diameter, is one which will be found useful when designing boiler stays, &c. The only thing to be added is the taper of the cottar, which, for those fitted as shown on the diagram, should be half an inch to the foot, but when fitted with a set screw, or other means of preventing the cottar from slacking, the taper may be as much as one and a half inches to the foot. The edges of the cottar should be slightly rounded, and should be fitted with great care. By making the cottar long it will serve to adjust the length of the rods.

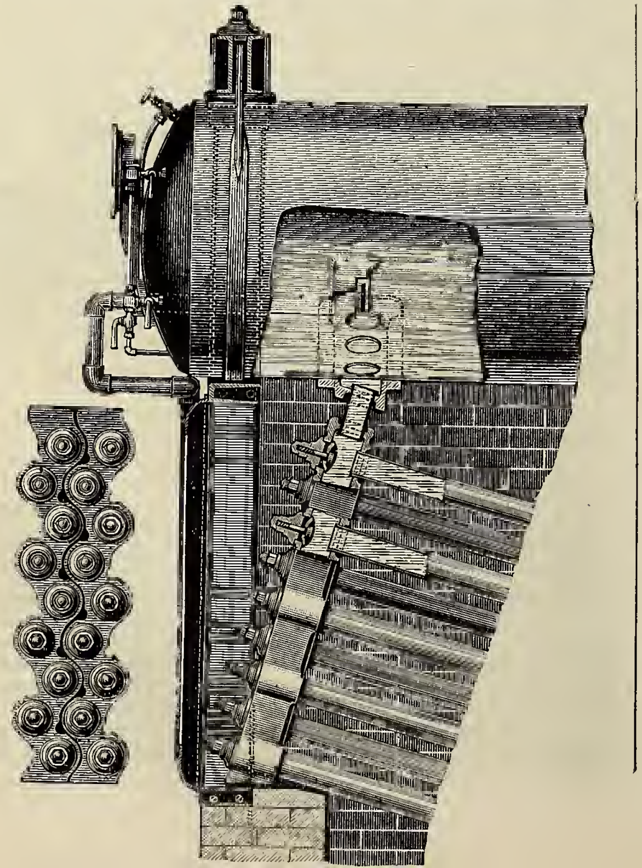
Note.—The dimensions in all cases are to be read off from the base of the diagram.

Adoption of the Electric Light at Bradford.—At the last monthly meeting of the Bradford Town Council a communication was read from the Local Government Board, giving authority to borrow £20,000 for electric lighting purposes. Alderman F. Priestman then moved resolutions accepting the tender of Messrs. J. and W. Beauland for excavating, brickwork, ironfounder and smith's work, masonry, carpentering, joinery, plumbing, glazing, &c., in connection with the electric lighting works, for £3,690; the tender of Messrs. Houldsworth and Sons, for the supply and fixing of three mild-steel boilers and fittings for £2,125; and the tender of Messrs. Siemens Brothers and Co., Limited, for the supply and fixing of dynamos and all the appliances for £12,543; the total cost of the proposed installation being £18,358.

THE GLASGOW EXHIBITION.

THE BABCOCK AND WILCOX WATER-TUBE BOILER.





THE exhibit of the Babcock and Wilcox Co., of New York and Glasgow, consists of one of their patent water-tube boilers, as illustrated above. It has 64 tubes, 4in. diameter and 18ft. long, with a steam receiver 4ft. diameter by 22ft. 4in. long, and is suitable for a working pressure of 180lb. per square inch. It is rated at 126 H.P., and is estimated to be equal to a Lancashire boiler 30ft. by 7ft. 6in. at 150lb. pressure. The rated horse power here means 30lb. of water evaporated from 212°, at 70lb. pressure for each horse power.

It will be seen that the boiler consists of a series of lap-welded wrought-iron tubes, placed zigzag one over the other, and connected at each end by vertical headers to a steam and water receiver placed above in a horizontal position; while below, at the back end, there is a cast-iron mud chamber or sediment collector, to which is attached the blow-off. These four different parts, when fitted together, constitute the boiler, and it is by the ingenious combination of these that the present state of perfection has been arrived at.

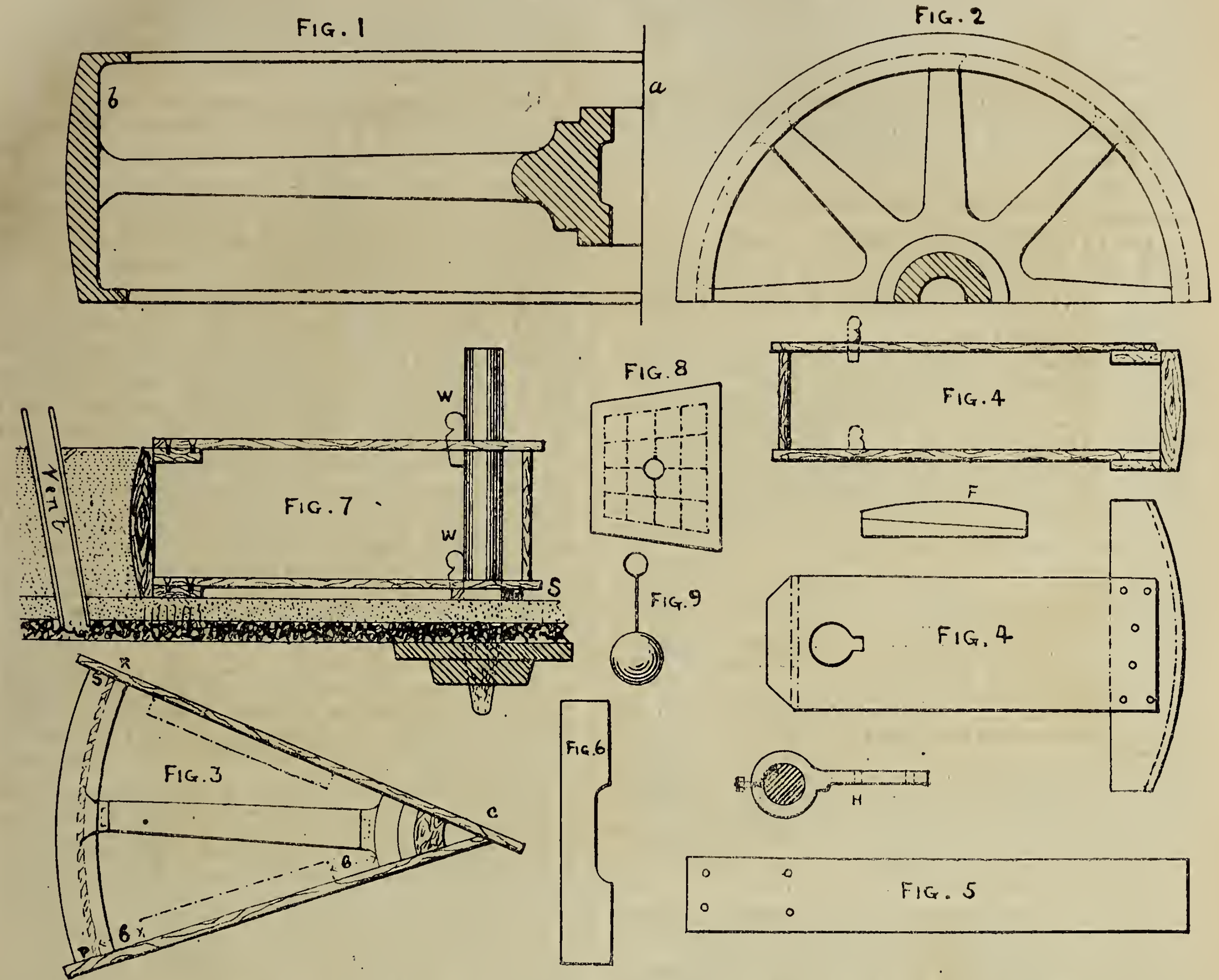
The tubes are connected with the headers by being expanded into accurately bored and tapered holes, the headers again being connected by tubes to a substantial riveted block on the underside of the water and steam receiver. This method is stated to give every satisfaction under all pressures and conditions.

The receiver itself is a cylindrical shell of Siemens-Martin steel, double riveted in the longitudinal seams, and single riveted circumferentially. The end plates form the segment of a sphere, or are what is usually termed dished. This being the strongest form in which they can be made, they do not require any further staying. The manhole, for internal examination, is placed in one end, and is formed by flanging the plate inwards and facing the edge, so that a metal to metal joint can be made.

The vertical headers have been usually made of cast iron, but the firm have on exhibition a wrought-iron one, similar in design to those in use, as shown in illustration. It is a beautiful piece

MOULDING FLYWHEEL PULLEYS.

For description see page 296.



of work, of great strength, and will considerably add to the confidence already placed in the safety of the boiler.

The fire is placed under the tubes at the front end; the flames and heated gases rise to the underside of the horizontal water drum, and thence pass downwards among the back portion of the tubes and on to the chimney. There is no fear of any evil effects from this arrangement, as the boiler is suspended from above by means of hoops round each end of the steam and water receiver, and is thus entirely free to move and accommodate itself to the variable movements consequent on expansion and contraction.

The water level is about the centre of the receiver, and by virtue of the greatest heat raising the temperature at the higher end of the tubes it circulates rapidly upwards at the front, along the chamber, down at the back, and on through all the tubes.

Owing to the rapid circulation, the greater part of the sediment has not time to deposit itself in the tubes or headers, but is carried onward until by gravitation it reaches the lowest part of the boiler at the back, where it rests in the collector, and is blown out at intervals through the cock placed there for that purpose.

There will, of course, be some deposit in the tubes, and this fact has not been overlooked. Opposite each tube, at either end in the vertical headers already mentioned, there is a small door, which is easily removed, and through which a scraper of improved construction is applied to the inside of the tube. This scraper, which we understand is the subject of a patent, accommodates itself to any unevenness, and is used from the front end, while the deposit is removed from the back or lower end of the tubes.

These doors, which are also used in the construction of the boiler for expanding the tubes, have double joints, to ensure lightness and safety. The inside one has an indiarubber ring, and in case of the nut or stud breaking, or in any way becoming deranged, the pressure on the door presses it against the inside face, and so prevents leakage until a new door is got ready.

For cleaning the outside of the tubes ample means have also been provided. In the side wall there are three long narrow doors, communicating with the different sections into which the flame space is divided. A flexible rubber hose, capable of withstanding 300lb. per square inch, is connected to the steam receiver, and the wrought-iron perforated pipe on the other end is put through the doors and among the tubes; the steam jets rapidly bring down the soot. For cleaning out there are large doors, as shown in the illustration; the one at the back is also for getting at the sediment collector. The fittings consist of a stop valve, a safety valve, two sets of water gauges, a feed check valve, a blow-off valve, and an improved pressure gauge, on the Schaffer and Budenberg principle. Great attention has been given to the delivery of dry steam to the engine—a point of importance well-known to all engineers. The absence of priming in this boiler makes the use of any special apparatus unnecessary; the only precaution to be taken is to place the stop valve on the opposite end of the steam receiver to that over the fire. The steam is, as it were, made at one end and discharged at the other, so that by the time it has traversed the receiver all particles of water in suspension have fallen out of it, and the steam is in a fit state to be conveyed to the engine without any further drying. We may say while referring to the steam space that, excepting under exceptional circumstances, the old idea of having a dome, or other storage for the steam, other than that contained in the boiler shell proper, is quite wrong, and so long as ample water surface is provided for the steam to disengage itself easily, nothing further is required.

So much for the construction and design of the boiler, and from what we have said it will be seen that the manufacturers have paid every attention to these particulars, even in the minutest details, and from the success that has attended their efforts to produce an efficient and safe steam generator, they have evidently not overlooked the many important features inseparable from efficiency and economy. The ratio of heating surface to fire-grate, and these two combined to the steam space, is based on actual experiments and nearly 20 years' experience. The result, as embodied in practice, is to be found in the continual efficiency of the boilers at work.

The following figures are taken from records of trials that have been made:—

In 1879 a trial of two boilers, 360 H.P., was made in America, when, from careful observation, the rate of evaporation was found to be at the rate of 9·2lb. of water per lb. of coal at a pressure of 70lb., and from a temperature of 180° with 12 per cent of refuse.

In 1883, at another trial in Pittsburgh, 10·9lb. of water were evaporated from each pound of bituminous coal—less 11 per cent of ash—at a pressure of 70lb. from and at 212°.

Again, during trials at San Francisco, with three different kinds of coal—viz., British Columbia, Welsh, and Washington—there were 11·1lb., 11·8lb., and 10·4lb. of water evaporated per pound of pure coal respectively. Efficiency trials have also been made in this country, and we extract the following from the company's report, dated July and August, 1885 regarding tests at the Gaythorn works of Messrs. J. and J. M. Worrall, dyers, Manchester, with a 140 H.P. boiler :—

	No. 1.	No. 2.
Heating surface	1,616 sq. ft.	1,616 sq. ft.
Grate surface, 6ft. 6in. by 4ft. 6in.	29 sq. ft.	·25 sq. ft.
Ratio of heat to grate surface	55 to 1	55 to 1
Duration of test	27 hours	18½ hours
Average observed steam pressure	75lb.	95lb.
Average temperature of water fed to boiler by injector	135°	275°
Pounds of coal fired	25,536	11,704
Coal consumed per square foot of grate per hour	31·7	21·6
Total water evaporated	216,000lb	118,400lb.
Water evaporated per hour	8,007lb.	6,400lb.
Water evaporated per pound of coal—actual conditions	8·46	9·85
Rated H.P. (one H.P. = 30lb. of water evaporated from 212° at 70lb. pressr.	140	140
Temperature of flue gases	700°	680°

In trial No. 1 the 27 hours include three stoppages, aggregating 2½ hours, in which but little steaming could have taken place, so that the figures represent ordinary working conditions.

From the careful manner in which the reports of the various tests of this boiler have been drawn up, it would appear that great care has been exercised to arrive at correct and reliable results.

We are informed that Messrs. Babcock and Wilcox have boilers representing 450,000 H.P. already at work, while 7,000 H.P. are under construction, a fact which speaks volumes for itself.

MOULDING FLYWHEEL PULLEYS.

BY A PRACTICAL MAN.

In the following article we propose to describe the method of moulding, in green sand, pulleys, say from 4ft. to 15ft. diameter, and from 10in. to 24in. broad. In a future article we will deal with the method of moulding, in loam, pulleys from 15ft. to 21ft. diameter, and from 24in. to 44in. broad. As whole patterns are never made for these sizes of pulleys, we will commence by describing the patterns required for the pulleys of the type shown in figs. 1 and 2.

The most important part of the pattern which requires to be made is the core box for the arm (see fig. 3). These boxes are made to suit the number of arms required in the pulley. Supposing there are eight arms, then the width of the box from P to S must be exactly one-eighth of the circumference of the pulley, while the length of the core box from the centre of the boss, C, to inside of rim, R, must be equal to the distance of A to B, fig. 1. To ensure the arm being kept in the centre, the best method is to mortice the arm into the boss and also into the rim, as indicated by dotted lines, but left loose, so that when the core is rammed into the box the back is drawn away and also the sides, leaving the arm in the centre of core. When the core is trimmed at the boss and back, the arm being tapered, it is drawn out and finished. It is essential to cut part of the core away from the joint, as indicated by dotted lines and dimensions in fig. 3. This is done to enable the cores to be placed in position in the mould more easily, as the cores generally swell when being dried, thus necessitating a great amount of rubbing-down of core if the part of the joint spoken of is not cut away.

When all the cores are placed in position, the space previously cut away is rammed with black sand. A segment, as shown on plan and section in fig. 4, is required to form the rim; a strickle board, to strickle a bed for the segment to bed upon, fig. 5; and a core board for centre core, fig 6. Having provided ourselves with the requisite patterns spoken of, we now proceed to mould the pulley, which will be found a very simple matter. In the first place, a hole must be dug in the sand some three feet larger in diameter than the pulley required to be moulded, and of the requisite depth to suit the rim segment.

In the centre of the hole dug out, lay down an iron plate with a taper hole in the centre, as shown in fig. 7. In this taper hole insert a strong spindle, about 6in. diameter. The plate is to be bedded down, and the spindle levelled; it then becomes a fixture during the process of ramming the pulley. Now form a coke bed, as shown in fig. 7, covering the coke with some straw. Great care must be taken in venting the bed well, by applying some 3in. or 4in. pipes, and also by the use of the vent wire.

These pipes are used to facilitate the escape of the gases generated in the pores of the sand during the operation of casting. As the gases, when mixed with air, form an explosive mixture of a violent character, it will be seen how necessary it is that every facility should be afforded for its escape and harmless ignition.

The mouths of the vent pipes should be lightly plugged with straw during the moulding operations, to prevent sand from getting in. At casting time the plug should be removed, and a few shavings substituted, which should be fired when the mould is run.

For such a casting as the one in question we require the sand to be more open and porous, or, as it is technically termed, "stronger" than would be necessary for small light castings. The following would be a suitable composition: To one barrowful of red sand, add one barrowful of road sand, two of black sand, and three sievesful of coaldust.

Assuming the bed is now ready for strickling, we place on the spindle a loose collar, with set screw, S; this can be lowered or raised to any height required. A loose arm, H, is also provided, to which the strickle board, fig 5, is bolted. When the board is fixed to the arm, the loose collar is adjusted so that the board may strickle the sand, as shown in fig. 7. When this is done, the segment shown in fig. 4 is applied and rammed up, as indicated in fig. 7. In ramming up the segment, short irons, say from 9in. to 12in. long, should be inserted at intervals to strengthen the mould. When the segment is completed, the wedges, W W, are knocked out, and the spindle hole, being oblong, allows the segment to be drawn back and turned round; the wedges are then replaced, and the operation is repeated until the whole circumference of the mould has been made. In the smaller sizes of pulleys plumbago powder blacking may be applied by the hand, and smoothed over; but in the larger sizes of pulleys it is better to paint the mould with liquid plumbago blacking, and smooth it over afterwards.

The blacking, we may explain, is applied to prevent in a great measure the burning of the sand, and consequent roughness of the casting. The part of the mould where the metal is run in, should be well sprigged, so as to strengthen it. The arm cores, having been previously dried in the stove, should now be placed in the mould, the gauge, F, and the centre core being used to set them by. For pulleys of this class over 10ft. diameter it is better to use covering cores, this being the simplest method of covering. Fig. 8 shows covering core, the dotted lines representing the core iron, with the riser hole in the centre. The more risers there are, the more readily will the air escape, and the easier it will be to keep the mould free from dirt.

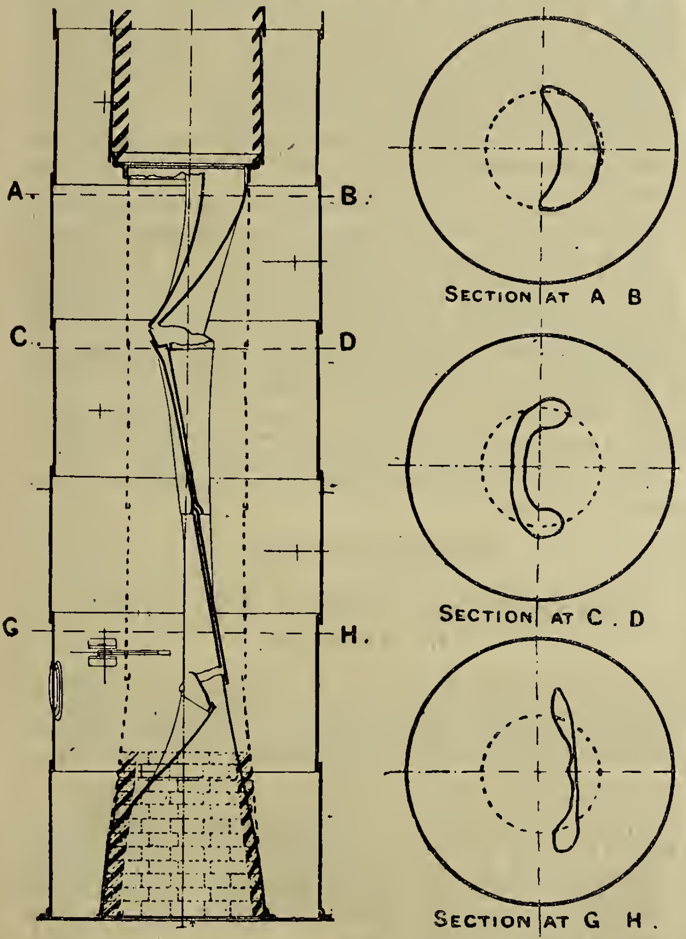
The metal should be run into the mould at the boss, as it will thus have a better chance of spreading itself. Assuming the rim to be closed in with covering cores, and the boss with a loam plate, wooden pegs should be inserted in the risers and runners, and the whole mould covered with boxes.

This being done, sand should be rammed in the boxes covering the whole pulley, the wood pegs of the risers withdrawn and replaced with an iron ball with loop hole, fig. 9, which should be removed when the fluid metal shows itself in the risers and the mould is filled with metal. In all instances where there is a large amount of metal to cast, a reservoir of sufficient size should be made at the mouth of the casting-goit or runner, so as to ensure a regular supply to the runner gate, and prevent the flowing in of any slag or other impurities. Pulleys of this class require to be well fed, that is, the metal in the mould kept in a state of agitation, by moving a thin wrought-iron rod up and down one or more of the runners or risers. This, however, as well as the weighting of the upper cope, to balance the head of metal in the runner, are points to be decided by the foreman or moulder in charge.

COLLAPSE OF A FURNACE TUBE.

An interesting Board of Trade Report has just been issued regarding an explosion which occurred on the 27th of January last, at the Liverpool Forge, Brunswick Dock, Liverpool, belonging to Mr. Charles Jones. The boiler which failed was of a vertical chimney type, consisting of a plain cylindrical shell with flat ends and a single central internal flue tube. The boiler was supported on a square base plate which rested on four short cast-iron columns, and was fired with the waste heat from a heating furnace. The shell measured 28ft. 3in. in length by 5ft. 7½in. in diameter, and $\frac{7}{16}$in. in thickness. The internal flue tube was in two portions. The lower, which was about 15ft. 6in. in height, measured 2ft. 6in. in diameter, while the diameter of the upper portion, which was lined with brickwork, was 3ft. 2¾in.

The boiler was fitted with two safety valves of the ordinary lever construction, about 4in. diam., and loaded to 50lb. on the inch. The equipment also included three test cocks for ascertaining the level of the water, as well as two dial pressure gauges. The boiler appears to have been made in the year 1864, so that at the time of the explosion it was about 24 years old. The report states that no information could be obtained as to any repairs prior to 1886; but at the beginning of October of that year it was inspected by a foreman boiler maker, who examined it internally, and also had some of the plates drilled. He found the plates up to the water line to have a uniform thickness of $\frac{5}{16}$in.. In consequence of the lower ring of plating being patched, he advised its renewal, and this was effected, the new plate being ⅜in. inch.



The boiler was used to supply steam to a hammer, and at the time of the explosion everything was in full work, steam was blowing from one of the safety valves, and the pressure gauges, which were connected to the lower part of the boiler, showed 58lb. Assuming the gauges were correct, the pressure of the steam in the boiler was probably a little over 50lb. on the inch.

On reference to the accompanying sketch, it will be seen that the lower portion of the flue tube collapsed throughout its entire length, being in some places crushed almost flat. The tube was ruptured at several places, and through the openings the steam and water escaped with considerable violence, demolishing the brickwork at the base of the boiler, and also damaging the roof under which the boiler stood. Five men who were working near the boiler at the time were injured by the explosion, two of them so seriously that they subsequently died.

With regard to the cause of the explosion, Mr. Woodthorpe, the Board of Trade surveyor who conducted the inquiry, states that on examination, he found the plates of the flue very much wasted by corrosion, the original thickness of $\frac{7}{16}$in. being reduced to about ¼in., while in some places it was even less. As is usual in the case of furnace tubes, the heat within the flue was frequently very intense, and in the case of a vertical flue this is specially trying, as the steam generated at the lower end crawls up the surface and tends to keep the water off the plates, causing it to become gradually more or less distorted.

For this reason, therefore, as the report points out, it is nearly impossible to calculate the actual collapsing pressure of old flues, as there is a great probability that the sections are not circular, and may not even be symmetrical about a given diametrical plane, while in applying any formula to old boilers with thin plates, especially where the resistance varies with the square or some greater power of the thickness, it is most important to determine this dimension accurately, as a small error so largely affects the result. Taking the thickness, however, at ¼in., the length as 15½ft., and the diameter as 30in., and applying Fairbairn's well-known formula for the strength of flue tubes, we get 83lb. on the inch in the cold-water pressure, which would collapse the flue if the thickness were uniform.

This, as Mr. Woodthorpe points out, assumes the flue to have been as nearly cylindrical in form as the joints would permit, and adds, "It is therefore reasonable to conclude that the flue failed under normal conditions, the plates being too thin to sustain the ordinary working pressure." This conclusion we entirely endorse, and in fact, knowing from experience how trying are the conditions under which worn furnace boilers are worked, it is a matter of surprise to us that the tube, in its wasted state, should have been able to work on so long.

LOCOMOTIVE COUPLING RODS.

The strains on locomotive coupling rods (says the *Railroad Gazette*) form a fruitful subject for discussion. Many rods are doubtless broken owing to being improperly keyed up, and are, therefore, subjected to excessive strains due to improper length, and rods are also broken from the gradual development of small flaws under the heavy strains to which the rods are subjected. It is, however, now generally admitted that one great cause of failure, especially on passenger locomotives, is due to the inertia and momentum of a rod, which is constantly changing the direction of its motion through the air. Many maintain that a coupling rod should be treated as a revolving body, and that the strains are caused by centrifugal force. Without entering into any examination as to which of these views is right, it is sufficiently evident that the strain which breaks the rods of a passenger engine is a cross-breaking strain acting in a vertical direction, and that fracture can be effectually prevented by making the rod of a suitable cross section to resist a cross-breaking strain. Rods of I section have been remarkably successful on the Pennsylvania and on other roads where they have been tried, and experience goes to prove that in fast passenger service an I section rod of moderate weight is less liable to fracture than a heavier rod of plain rectangular section. The use of large crank pins minimises wear, and renders it possible to use bushed ends, which, once drilled true in a suitable double-spindle vertical boring machine, cannot get out of adjustment. The two most important sources of fracture are thus eliminated in a very cheap and simple manner. It may be objected that in milling or planing an I section rod a great deal of metal is wasted, but this objection can be overcome by adopting the practice of the Chicago, Burlington, and Quincy, where the rods are forged to an I section by using suitable dies under the steam hammer.

ON CAST IRON FOR MECHANICAL PURPOSES.—I.*

In this paper the author treats in great detail the subject of cast iron, with the view of obtaining an insight into the principles that govern the choice of mixtures that will give the best results in practical work.

The author points out that whereas a tensile strength of from 10 to 12 kilograms per square millimetre (6½ to 7½ tons per square inch) was formerly an average resistance for iron run direct from the blast furnace, at the present time mixtures are run at the second melting which easily show a breaking tensile stress of 14 to 15 kilograms (9 to 9½ tons), and these latter figures have been far surpassed in America, where cast iron has been obtained which has a breaking tensile stress of 32·275 kilograms per square millimetre (20½ tons per square inch), and Gruson, of Buckau, and Ganz, of Buda Pest, have secret mixtures, which possess an extraordinary tenacity and chill perfectly. They produce the so-called Hartguss.

The property of chilling that Hartguss possesses has given rise to a great confusion of ideas, and has caused the other remarkable properties of this material to be neglected. This has led other foundries to give the same name to mixtures made with ordinary chilling iron that can only discredit the true product.

Tough cast iron should be moderately carburated, and should contain some manganese, a little silicon, and only traces of sulphur and phosphorus. It is almost impossible to define the proportions in which these elements should be present, because they may vary considerably without altering the strength, although the slightest variation in the amount of foreign matter materially affects the properties of the mixture. Besides the carbon, manganese, silicon, sulphur, and phosphorus, there are other ingredients which appear in cast iron, though less often, such as arsenic, copper, and titanium ; and others, as aluminium, potassium, magnesium, and calcium, which often figure in old analyses, and are present in small quantities more often than is supposed.

The opinion has been held by some that the best results should be obtained by using a cast iron that contains only iron and carbon ; others again have held that other ingredients might be present up to 10 per cent of the whole without rendering the metal improper for use. The author remarks that his investigations show that both these views are erroneous, although the first opinion might possibly be correct if it were possible to obtain chemically pure carbon and add it to chemically pure iron, and the second might be correct if the foreign ingredients were added in just the necessary proportions to neutralise one another.

The true worth of any given cast iron can only be ascertained by direct physical tests, which give results of much more value than those obtained by analysis. The usual physical tests are those of tension, bending, or impact, but to give a complete insight into the properties of an iron it ought to be tested for hardness as well. It is not unusual to find a cast iron considered unsatisfactory that will stand tensile bending and impact tests much better than an iron that is more highly prized because it is easy to work and runs sound castings.

During its formation cast iron dissolves more carbon the hotter it is, and the excess is precipitated during cooling. This excess forms scales of graphite, which results in a multitude of soft and weak points being distributed throughout the mass. In consequence of this, graphitical iron is soft and weak. On the other hand, combined carbon, as is well known, when totally dissolved and present in several units per cent, renders the metal brittle and as hard as tool steel. In foundry practice, both these extremes are to be avoided, and the endeavour should be to obtain a metal which is strong and yet soft enough to be utilized.

The author investigates this question at length, and, by plotting the results of tests as curves, shows that the maximum strength is attained with a mixture in which the amounts of graphite and carbon are nearly equal, or the combined carbon slightly in excess of the graphite. Such a mixture produces a mottled iron—neither grey nor white. From this it results that grey iron can be strengthened either by reducing its proportion of graphite or increasing its proportion of combined carbon ; and white iron may be strengthened by increasing its percentage of graphite or lowering its percentage of combined carbon.

Boiler Explosion at Durham.—On Wednesday, the 13th inst., a destructive and fatal boiler explosion occurred at Murton Colliery, Durham. The boiler and engine houses were completely wrecked and the working machinery disorganised, while twelve persons were injured, one of them so seriously that he died the following day.

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* Foreign Abstracts, Civil Engineers.

THE MANUFACTURE OF COKE.

BAUER'S SYSTEM.

At the present time there is being constructed by the Carlton Iron Company, Limited, at Stillington, in the county of Durham, an experimental block of forty coke ovens, on the principle introduced by Dr. Theodor Bauer, and successfully adopted at several Austrian collieries, as well as by Messrs. Schneider and Co., in France ; and more recently by Messrs. Baird and Co., at their Ayrshire collieries.

Bauer's system appears to resemble the application to coke-making of Sir W. Siemens' regenerative gas furnace used in steel manufacture. There are, however, no gas producers, as in the Siemens furnace, the heat used being that obtained from the gas evolved in the retorts during the process of coking. These retorts are 16in. wide, 6ft. long, 10ft. high, and each contains about two tons of coal. The retorts are grouped in batteries, and surrounded by gas-heating chambers, the gas being drawn off from each retort into a main flue running along the top of the ovens, from whence it passes to the condensing apparatus for the recovery of the bye-products from the gas, or to the mixing chamber, where it is mingled with a properly regulated quantity of air, already raised to a high temperature by being drawn through firebrick passages heated by the waste gases. The mixture of heated gas and air then enters the combustion chamber adjoining the retort, raising it to a very high temperature. No escape of smoke is possible, and the finest hard blast furnace coke is said to be produced from any quality of coal, and in much less time than by other systems. On this system it is estimated that a charge of two tons can be coked in twenty hours. The retorts are charged from the top, and are so constructed that they are practically self-discharging, the lower portion of the retort being curved forward to the mouth, which is situated at the bottom of the front side, in such a way that as soon as the iron door securing the mouth is opened the mass of coke slides down out of the retort on to the platform by its own weight, leaving the retort empty and ready to receive another charge at once.

By a suitable damper arrangement each retort can readily be isolated from the rest of the battery for discharging, refilling, &c., without affecting the remainder, while another advantage claimed by the system is that a larger proportion of bye-products is obtained, owing to the minimum consumption of gases for combustion and the small amount of waste, and provision is being made for utilising the tar and ammoniacal residuals.

The system generally appears to be based on scientific principles, and to possess so many advantages over the old extravagant method of coke manufacture that its wide adoption can only be a question of time, and we shall watch its development with considerable interest.

PRODUCTION OF IRON AND STEEL IN AMERICA.

The annual statistical report of the American Iron and Steel Association, giving comparative statistics of the iron trade for the last two years, has lately appeared. The statistics given are important in themselves, and they suggest a comparison of production and prices for several years.

The production of pig iron in the United States for 1887 was 6,417,148 gross tons (or 7,187,206 net), against 5,683,329 gross tons in 1886, an increase of about 13 per cent. Of the year's output, about 60 per cent was made of bituminous coal, mostly coke ; 26 per cent by coke and anthracite, 6 per cent by anthracite alone, and 7 per cent by charcoal. Twenty-two states and one territory made pig iron in 1887.

The production of Bessemer and Clapp-Griffiths steel was 2,936,033 gross tons, a gain of 29 per cent on the production of 1886. Pneumatic steel was made in 11 states last year, against 9 states in 1886, the new states being Virginia and Indiana.

Eight new Bessemer and three new Clapp-Griffiths plants were completed in 1887, and at the close of the year three Bessemer works were in the course of erection. The total number of completed Bessemer steelworks in this country at the close of the year was 43, with 89 converters, of which works eight were Clapp-Griffiths.

The production of steel rails for 1887 was 2,049,638 gross tons ; for 1886, 1,526,410 ; and for 1885, 959,471 tons, showing an increase since 1885 of nearly 114 per cent.

The production of open-hearth steel was 322,064 gross tons, an increase of 47 per cent on the production of 1886.

CORRESPONDENCE.

We do not hold ourselves responsible for the opinions of our Correspondents.

THERMO-DYNAMIC ANALYSIS OF THE GAS ENGINE.

To the Editor of "The Practical Engineer."

Sir,—Referring to the correspondence on this subject, I should like to observe, with regard to the heated poker, that long-continued experiments show me that nothing less than a bright red will ignite London gas. I don't know what result a better gas may give. But, sir, instead of agitation being an advantage, is it not probably the cause of a part of the loss in present gas engines? Were there no agitation, then along the centre line of the cylinder would be a core of hot gas, slightly cooler at its outer part, due to the slow cooling of conduction. Now, if this gas be agitated, it will cool much more rapidly, for its hottest particles will be in close and incessant contact with the cool cylinder walls. Doubtless a hot gas enclosed in a cold vessel will not cool nearly so rapidly at rest as it will set in motion. Although in present gas engines the hot gas is in the cylinder only a fraction of a second, yet the agitation is so violent that probably half its available heat passes into the water jacket.—Yours, &c., A. J. G.

London, June 11th, 1888.

THE STEAM ENGINES AND BOILERS BILL.

To the Editor of "The Practical Engineer."

Sir,—In the manuscript of my last letter I stated that the boilers I referred to gave evidence which I thought sufficient of the truth of the second inspector's report. To satisfy "Boiler," I may say that one of the boilers in question measured 28ft. in length by 7ft. in diameter and ⅝in. in thickness. It was made of iron plates, single riveted, and had worked for upwards of twenty-five years, the greater part of the time night and day, the blowing-off pressure being 40lb. The boiler was wasted away to one-third its original thickness along the bottom, and in the process of removal was considerably flattened. I can certify that for the last 20 years of its use the brickwork setting was never removed. I hope this will satisfy "Boiler." I myself think it enough for one so versed in Admiralty and Board of Trade rules, and I think he would have a hard task to find either an Admiralty or a Board of Trade inspector who would have sanctioned an increase of pressure under the above conditions. In advocating the granting of certificates to enginemen, I do not consider I am doing anything to degrade their position. In my opinion the opponents of certificates have utterly failed to show that it would be productive of anything but good. It would certainly not increase the number of boiler explosions or diminish the safety of the public.—I am, sir, yours, &c., Ignorance.

June 11th, 1888.

QUERIES AND REPLIES.

Hot-air Engines.—I should esteem it a favour—and I am sure it would be interesting to other readers of your valuable paper—if some one would furnish full working particulars of a small hot-air engine. I have a 4in. lathe, and would like to make a motor to drive it. Can I buy the castings for one that size; if so, where and at what cost? How are the cranks set? What would be the cost per week of 54 hours of heating such an engine with gas? Any information or article on the subject would be thankfully received.—Hot Air.

Answer.—You can hardly have followed our pages very carefully or for long, as several of a series of articles on the subject have already appeared in our columns. See our issues for January 6th, February 10th, and May 18th. These do not give working drawings for any particular size, but the principles of the various types are carefully explained, and with the information they afford we think you ought to be able to solve your difficulty.—Editor.

Rivet Furnace.—Can any reader of your valuable paper give me some idea of an economical rivet-heating furnace for two stationary riveting machines?—P. H.

Copper Boiler.—Could any reader inform me what would be the most suitable kind of copper boiler, with fire box, for 2½in. by 3½in. stroke horizontal engine, to be heated by a lamp or otherwise, and what would the dimensions be?—F. W. T.

Concave Circular Saw.—Can any reader describe the use of a concave circular saw? It is supposed to be attached to the end of saw spindle outside of bench and driving pulleys.—H. C.

Machine for Stamping Nails.—Will one of your readers give me the name of a good firm to manufacture a special press for stamping out nails?—F. C.

Thin Plates.—Can any of the readers of your practical and valuable paper inform me if it is possible to get thin sheets of iron or steel (say 20's gauge) as large as 8ft. 6in. by 4ft. 6in.? If so, where?—Chalkline.

Smoke-consuming Furnace.—Can any of your readers give me the address of the makers of Thompson's smoke-consuming furnace?—J. E.

Setting Slide Valves.—Would any of your readers be good enough to explain the method of the setting of the valves of a common condensing marine engine (not compound)? There are two common expansion slide valves, with link motion between cylinders, fitted with hand gear. The cylinders are 24in. in diameter, and 2ft. stroke.—Amateur.

Pitch of Propeller.—Can any of your readers inform me how to alter the pitch of a propeller? Suppose, for instance, a chief engineer receives orders to take the pitch of his propeller by measurement while the steamer is in dry dock, how should he proceed? A sketch would oblige.—Port Glasgow.

TO CORRESPONDENTS.

Science Examinations.—In answer to "A. R," we beg to say that the question of printing the questions and replies in connection with the recent science examinations is under consideration, and if it is found that a sufficient number of our readers are interested in the subject the course adopted last year will probably be repeated.—Editor.

MISCELLANEA.

The Glasgow Exhibition.—The admissions to the Glasgow Exhibition on Saturday were: By payment (adults), 27,574; by payment (children), 6,376; by railway, steamer, and coupon tickets, 3,518; by season tickets, 23,613; attendants, 3,799; total for the day, 64,880; previous admissions, 1,114,599; total since the opening day, 1,179,479.

The World's Steel Production—The production of Bessemer steel in the eight chief iron and steel producing countries of the world amounted last year to 7,269,767 tons, as compared with 6,034,115 tons in 1886, showing an increase of 1,260,094 tons, or 20 per cent. The production of open-hearth steel in the same countries in 1887 was 1,672,340 tons, being an increase of 450,419 tons on the previous year.

To Prevent Steel Implements Rusting.—The following is said to be a good application to prevent metals rusting: Melt 1oz. of resin in a gill of linseed oil, and while hot mix with it two quarts of kerosene oil. This can be kept ready to apply at any time with brush or rag to any tools or implements required to lay by for a time, preventing any rust, and saving much vexation when the tool is to be used again.

Failure of Railway Wheels.—During the past ten years the total failures of passenger car wheels in Great Britain have been only 104, an average of about 10 per year, or one failure per annum out of every 15,000 wheels. For the past seven and a half years not a single person has been killed or injured from failure of tires, and for eleven and a half years none have been killed, and only five injured.

Pneumatic Dynamite Gun.—The pneumatic dynamite gun, which is being constructed by Lieutenant Zalinski for the Italian Government, is 45ft. long and 15in. in diameter, and designed to throw 600lb. of explosive gelatine a distance of two miles. A similar gun is being constructed for the dynamite boat ordered by the United States Government, which it is said will be ready for launching in about a fortnight.

Electric Coal-mining Machine.—A new coal-mining company, known as the Electric Motor Company, which has a patent for mining by electricity, is about to establish a plant at Phillipsburg, Pa., for the mining of an area of ten miles. The plant, as a whole, is to consist of a central dynamo, conducting wires, coal-cutting machine, electric lamps, and motor attachments for hanging the mine cars. The inventors claim, as an advantage in favour of their coal-cutters, that a single machine will not weigh more than 500lb. According to estimates, which, it is claimed, are made upon actual tests, the new device will considerably reduce the expenses of mining.

Boiler Explosion on a Tug at Middlesbrough.—On Saturday last, a serious explosion occurred on board the steam tug Admiral, the property of the River Tees Commissioners. The Admiral was lying at the wharf of the Teesside Iron and Engine Works, at Middlesbrough, and arrangements were being made to proceed to sea, when the boiler exploded. At the time of the explosion the engineer was oiling the engine, and his dead body was afterwards found in the forepart of the tug. The captain was blown on to the wharf, and was afterwards picked up insensible, as was also the third hand, who was also blown on to the wharf.

Wage Disputes on the Tyne.—The engineers employed by the North-Eastern Marine Engineering Company, the Wallsend Slipway Company, Messrs. Wigham, Richardson, and Co., Messrs. Hawthorn, Leslie, and Co., Messrs. R. Stephenson and Co., and the Palmer Company, numbering in all about 1,000 workmen, are on strike for an advance of 2s. per week. The platers and boilermakers in the whole of the yards are demanding an advance of 7½ per cent., but their notice does not expire till the end of this month. If a settlement be not arrived at by that time 7,000 men will come out on strike on the Tyne, Wear, and Tees. The strike of the Tees and the Hartlepool shipyard men has terminated, the men on Saturday evening determining to abandon their demand for an immediate advance of 5 per cent and to accept the employers' offer of an advance of that amount from July 3. The operations, which have been suspended for 16 days, have been resumed.

Output of Russian Oil Wells.—A well at Baku, called the "Wet Nurse," has averaged 32,000 gals. per day for 12 years, making a total of 140,000,000 gals., while the record of the first 84 days' yield of the "Droogba" well, driven by Nobel Brothers, is as follows: For 43 days it spouted at the rate of 3,400 tons a day, 900 tons for 30 days, and 600 tons for 11 days. The well was then plugged, and the supply kept underground for further wants.

The Chinese in Australia.—The action of the Australian Government in prohibiting the immigration of Chinese into the colony has occasioned great consternation amongst British merchants in China, and the Hong Kong Chamber of Commerce have passed a resolution to the effect that the subject demanded "the very grave consideration of Her Majesty's Government—first, because it is not consonant with British methods of government or justice that tradal regulations should be instantly suspended without ample notice to permit of those interested conforming therewith, for the action of these Australian colonies threatens to involve those engaged in the trades affected by the new regulations in very serious loss, for which, apparently, no compensation is offered. Merchants depending upon the good faith of the Australian Governments, having complied with regulations in force when their engagements were made, are, at a moment's notice, without warning of any kind, subjected to limitations with which they are powerless to comply." The second reason given is that the action of the Australians "is fraught with most serious consequences to British interests in China . . . . and will doubtless very seriously affect the promotion of England's friendly intercourse with China in the near future."

The Inspection of Quarries.—A bill has been introduced by Mr. Broadhurst to provide specially for the regulation and inspection of slate quarries and other quarries in which persons work in getting stone, coprolites, or other minerals, clay and brick earth excepted. It is proposed that the Factory Acts shall not apply to these places; but that the regulations shall be as follows: The employment of a boy or a girl under the age of ten is forbidden altogether. The longest time of employment permitted for a boy or girl under the age of sixteen, or a woman, in a week is 54 hours, and in a day 10 hours. And no employment is allowed between nine at night and five in the morning, or at all on Sunday, or after two o'clock on Saturday afternoon. Where an accident occurs that causes injury or loss of life, the Home Secretary may appoint an inspector and an assistant, having legal or special knowledge, to form a court to inquire as to the cause of the accident. Special powers and duties are conferred by the bill upon coroners with regard to inquests on persons killed by accidents in quarries. In quarries where more than fifty persons are employed, a man is forbidden to act as practical manager unless he has had at least five years' practical experience of the working of a quarry.

SELECTED PATENTS.

APPLICATIONS FOR LETTERS PATENT.

June 6th.

8247 Self-lubricating Loose Pulleys, B. Berry, G. Jennings, and A. T. Jennings, Bradford.
8252 Motors to Work with Combustible Gas, G. Johnston, Glasgow.
8259 Hydraulic Motor, T. Hartley and T. White, Liverpool.
8263 Manufacture of Cutlery, W. B. Hatfield, Sheffield.
8267 Direct-acting Steam Engines, G. A. Barth, London.—[Complete Specification.]
8270 Ventilators, C. Ellis, London.
8272 Pumps, P. Mitton, London.—[Complete Specification.]
8273 Hydrocarbon Engines, O. Kosztovits, London.—[Complete Specification.]
8276 Couplings for Railway Vehicles, C. Lock, London.
8278 Car Couplings, J. K. Freeman, G. W. Harris, J. A. Liddell, and W. E. Harris, London.—[Complete Specification.]
8279 Fire Escape, W. Bruce, London.—[Complete Specification.]
8280 Thill Couplings, L. Miller and M. L. Wright, London.—[Complete Specification.]
8285 Nails, L. B. Phillips, London.
8286 Bending Metal Rails, C. Reinhold, London. (E. Schrabetz, Austria.)—[Complete Specification.]
8293 Propellers of Ships, H. J. Haddan, London. (W. Hofmann, Austria.)
8296 Door Locks, E. Edwards, London. (J. Aubry, France.)
8300 Starting Gear for Gas Engines, E. Delamare-Deboutteville and L. P. C. Malandin, London.—[Complete Specification.]
8304 Hydraulic Machinery, J. Fraser, temporarily Belgium.
8305 Propelling Spring Oar, Roger, Baron de Mauni, London.—[Complete Specification.]

June 7th.

8307 Metal Pipes, A. Barraclough, Yorkshire.
8310 Smoke-consuming Automatically, P. Roberts, Bristol.
8312 Valves, W. Rose and O. F. Vollhard, of the firm of W. Rose and Co., Manchester.
8315 Pressure Gauges, W. P. Ingham, Middlesbrough.
8316 Planing Machines, J. Anderson, Newcastle-on-Tyne.
8317 Petroleum Motors, A. Altmann, Germany.—[Complete Specification.]
8318 Flues for Steam Boilers, R. Baird, Glasgow.
8323 Screw Nails, H. Wells, London.—[Complete Specification.]
8326 Slide-valve Mechanism of Steam Engines, T. Henderson, London.
8329 Hydraulic Accumulators, C. Prott and R. Seelhoff, London.
8337 Propelling Vehicles, P. L. Brendel, London.—[Complete Specification.]
8340 Blast Pipes for Locomotive Engines, D. McDowell, London.
8343 Hoisting Engines, P. Vonhof, London.
8345 Brakes, P. Vonhof, London.
8349 Pumping Engines and Motors, J. C. R. Okes, London.
8350 Steam Boilers, A. Stirling, London.—[Complete Specification.]
8373 Gas Stoves, W. R. Lake, Middlesex. (G. H. Burrows, United States.)

June 8th.

8375 Manufacture of Screws, J. H. Ladd, London.—[Complete Specification.]
8378 Anchors, H. Hutchinson, Newcastle-on-Tyne
8380 Oil Lamps, E. Sarjeant, Birmingham.
8382 Carding Engines, D. B. Briggs and W. Eastwood, Yorkshire.
8385 Ventilating Apparatus, J. McConachy, Glasgow.—[Complete Specification.]
8394 Water-heating Apparatus, T. Nixon and T. Buchanan, Glasgow.
8398 Machine Guns, G. A. Farini, London.
8400 Hydraulic Presses, T. C. Roberts-Horsefield and R. Porter. London.
8401 Electric Batteries, E. W. Clifton and V. Robinson, London.
8404 Bicycles, J. W. Emsley, London.
8407 Self-acting Mules, S. Marlor, London.
8410 Purifying Metals, L. A. Groth, London. (L. M. D. Pellegrin, France.)
8417 Machine Tool, J. Martignoni, London.—[Complete Specification.]
8422 Spindles of Valves, T. W. Baker and G. Fowler, London.
8423 Turning Ingots while under a Hydraulic Forging Press, G. Siddell, London.
8427 Extraction of Precious Metals from Ores, J. E. Guild, London. (D. R. S. Galbraith, New Zealand.)
8428 Quick-firing Guns, H. S. Maxim, London.
8429 Artificial Draught in Steam-boiler Furnaces, H. F. Green and E. J. Curtin, London.
8431 Valves, W. Hartley and W. H. Rose, Bradford.
8440 Power Machines, J. Lawrence, London.—[Complete Specification.]
8441 Syphon Lubricator, J. Bellis and E. M. Dadd, London.

June 9th.

8450 Steam Boilers, R. Low, Glasgow.
8454 Pulverisor, G. E. Coleberd, Hampshire.
8455 Corrugated Shells for Steam-boiler Furnaces, W. Hargreaves and W. Inglis, Glasgow.
8456 Apparatus for Pulverising Substances, M. Friedrich, Glasgow.—[Complete Specification.]
8457 Telephones, L. Mellett, London.—[Complete Specification.]
8472 Fret Saw, E. Whibley, London.
8479 Flexible Tubes for Fluids under Pressure, R. Gagné, London.
8483 Toothed Gearing Wheels, M. Mannesmann, London.
8484 Universal Joint for Coupling Shafts, M. Mannesmann, London.
8487 Construction of Tubular Shafts, M. Mannesmann, London.
8497 Fire Escapes, T. Walters, London.
8498 Bicycles, W. W. Clegg, London.
8501 Caulking the Seams of Steam Boilers, W. Keen and R. H. N. Alleyne, London.

June 11th.

8512 Automatic Valve, S. J. Southon, C. W. Franklin, and W. Stone, Southampton.
8520 Marine Governor, F. Hunt and C. Crockford, Manchester.
8524 Water Gauges, F. C. Lynde, Manchester.
8525 Electric Trembling Bells, F. L. Rawson and P. Jolin, London.
8528 Tube Expanding Plyer, W. H. Swingler and F. H. Aircy, Birmingham.
8531 Steam Pumps, A. J. Boult, Middlesex. (J. P. Northey, Canada.)
8534 Rotary Engines, A. J. Boult, Middlesex. (W. A. Avis, Canada.)
8546 Joints for Metal Vessels, W. H. Wheatley, Middlesex. (E. Barrath and V. E. Knecht, United States.)—[Complete Specification.]
8549 Stone Crushers, A. C. Nagel and A. Linnenbrugge, London.
8550 Purifying Feed-water in Boilers, E. Lechner, London.
8553 Air Brakes, A. R. Boluss, London.—[Complete Specification.]
8568 Purifying the Feed-water for Steam Boilers, D. Stark, London.—[Complete Specification.]
8571 Supplying Water to Boilers, S. Pitt, London. (T. J. Kieley, United States.)—[Complete Specification.]
8572 Ventilation of Ships, W. R. Hayes, London.

June 12th.

8583 Steam Chests of Steam Engines, J. Landye, Dublin.
8593 Safety Valve for Steam Boilers, W. J. Bosley and W. W. Dickson, London.—[Complete Specification.]
8596 Automatic Telegraphy, J. Y. Johnson, Middlesex. (E. J. Mallett, United States.)—[Complete Specification.]
8602 Brake Mechanism, R. L. Hattersley and R. Hall, Keighley.
8605 Constructing Refrigerators, Zimmerman Refrigerator Company, London.—[Complete Specification.]
8620 Hydrocarbon Motors for the Propulsion of Light-wheeled Vehicles, E. Butler, London.
8624 Centrifugal Separators, H. Petersen, London.—[Complete Specification.]
8629 Blades of Propeller Wheels, J. E. T. Bartlett, London.—[Complete Specification.]
8633 Feed-water Regulator for Steam Boilers, O. Imray, London. (F. Cook and B. Thoens, United States.)—[Complete Specification.]
8649 Valve Taps, J. Walker, London.
8650 Stop Cocks, J. Walker, London.

June 13th.

8651 Locks, T. Schönheer-Schöner, Leeds.
8657 Dynamo-electric Machines, H. Barcroft, Belfast.
8664 Admission of Air to Steam-boiler Furnaces, E. Beck and J. J. Blackley, Liverpool.
8667 Hydraulic Apparatus for Starting Tramway Cars, J. Stark, Liverpool.
8668 Cartridges for Blasting in Mines, M. Settle, Manchester.
8682 Wind Engines, G. G. Picking and W. Hopkins, Middlesex.
8686 Steam Engines, F. W. Cannon, the Carlton Engineering Co., London.
8687 Ventilator, E. Newton, Hitchin.
8688 Drilling Machines, H. F. Ainley and A. C. Oakes, London.
8695 Lamps, W. Defries and V. I. Feeny, London.
8696 Gas Motor Engines, C. W. Pinkney, London.
8697 Mariners' Compasses, J. Sandeman, London.
8700 Electric Batteries, L. M. J. C. C. Renard, London.
8701 Lubricating the Axles of Vehicles, A. Gascoigne, London.

June 14th.

8703 Motive-power Engines, J. F. Shaw, Manchester.
8704 Fire Escape, H. C. Harrison, Liverpool.
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8725 Steam-boiler Furnaces for Consuming Smoke, W. Parker and R. Turner, London.
8745 Liquid Meters, G. Teideman, London.

PUBLISHERS' ANNOUNCEMENTS.

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EDITORIAL NOTICES.

All communications for the Editor of this Journal should be addressed to 6, Victoria Station Approach, Manchester.

Communications intended for insertion in the current week's issue should reach us not later than Tuesday Evening.

We cannot undertake to return rejected manuscripts or drawings unless accompanied by a stamped and directed envelope.

Contributors are requested to write on one side only of the paper. Sketches should be sent on separate sheets.

TO ADVERTISERS.

Advertisements intended for insertion in the current issue should reach us on Wednesday morning at the latest.

THE
PRACTICAL ENGINEER.
JUNE 29TH, 1888.

FALLACIES RESPECTING THE "PRACTICAL" MAN.

So much is thought in some quarters of the so-called "practical" man, in whom many steam users seem to place such implicit confidence, that a few samples of the ill effects of trusting too much to the judgment of ordinary workmen will doubtless prove of service. Whilst it may be quite justifiable and safe in many simple matters to act upon the advice of a skilled workman, who has had a large amount of practical experience in one particular branch of his handicraft, in preference to being guided by a mere theorist, who has to arrive at his results by calculation and reasoning only, without having had much practical experience in actual work by which to check his theories, it should not be forgotten that ordinary workmen, as a rule, are not competent either by training or experience to determine the strength and adequacy of a structure as a whole, for all the stresses which it may have to sustain under varying conditions.

An ordinary working boiler-maker, for instance, may be a very expert plater or riveter, able to make a perfectly tight seam and do excellent work generally, so far as mere craftsmanship goes; but, as a rule, he has no idea of how to determine the strength of a flat surface, such as, for example, the end plate of a boiler, or a combustion chamber, to resist any pressure which may be required to be put upon it, or the sufficiency of a large vessel, like a steam boiler or kier, for any particular load.

Numerous instances of the danger of trusting to workmen in carrying out structural alterations can be adduced which have come within the writer's own experience, and several instances may be found in the Board of Trade reports of boiler explosions. Take, for example, the explosion which occurred at a dyeworks at Leeds, on September 21, 1885, a description of which will be found in Report of Preliminary Inquiry No. 134. In this case, the boiler was of the old Galloway type, and three of the Galloway tubes in the large oval flue tube, having been leaking, were removed at different times by the boiler-makers who were sent for to do the repairs, and blank flanges applied to the openings in the practically flat surfaces in the top and bottom of the oval-shaped flue tube. It never seems to have struck those who were responsible for these repairs that the removal of three vertical cross water tubes in a line with each other, and so close together as these tubes were, seriously reduced the strength of the weak oval tube at these parts to resist collapse. The third tube was removed on Saturday, the 19th of September, and on raising steam in the boiler the first time after the repair, on the morning of Monday, September 21st, the oval flue tube collapsed and ruptured, under a pressure of 45lb. per square inch, or 11lb. per square inch less than the usual load upon the safety valves, killing two men and seriously injuring a third. In this case the work was entrusted entirely to "practical" men. Although the boiler was insured, it was not thought necessary to apprise the insurance company's engineers or inspectors of the contemplated structural alteration, or the disaster might have been prevented. The repairs were in the hands of good practical men, who knew how to make a tight repair, and would be sure to put on the new circular patch plates over the openings caused by the removal of the cross tubes satisfactorily, and make a tight job, and as the boiler-makers and the firm's engineman were "practical" men only, they knew very little more than this. The tubes were removed, with the result that the engineman himself fell a victim to his own want of theory or knowledge, and the death of another man was involved in his.

This, we may add, is only one of many instances which have occurred in precisely the same way where boiler-makers have removed vertical cross tubes from the oval flue tubes of Galloway boilers, without adding anything else to compensate for the weakening effect thus caused; whilst the removal of flanged seams, T hoops, and flanged "Bowling" hoops, and the substitution of flat belts on furnace tubes of high-pressure boilers, are matters of almost every-day occurrence.

Not long ago the front end plate of a Lancashire boiler required repair at the lower part. The boiler-makers engaged to do the work removed the portion below the tubes, including the mudhole, and as much of the flat end plate as was comprised between the centre of each furnace tube and the bottom. This part, prior to the repair, had been strengthened by two gusset stays, one on each side the mudhole, in addition to being stiffened by the mudhole mouthpiece, and was $\frac{9}{16}$in. thick. Either because the gussets interfered with cleaning in the lower part, or because the boiler-makers considered the stays superfluous, they were left out when the new piece of plate was inserted, while the latter, instead of being $\frac{9}{16}$in. thick, as before, was only $\frac{5}{8}$in. The working pressure being 55lb. per square inch, this thin flat plate, unsupported in any way over so large a surface, was quite inadequate to withstand the strain put upon it, and became seriously bulged, and eventually fractured through a distance of some 20in. at the bottom of the end plate and a length of about 13in. at the lower part of the mudhole; but, fortunately, the piece was not blown entirely out with disastrous consequences, as has happened in other cases with weak front end plates below the tubes. Had the boiler-makers in this instance known how to calculate the strength of flat unstayed surfaces, or had the owners of the boiler consulted engineers competent to advise on such alterations, the danger would not have been incurred.

Still more recently a locomotive boiler exploded, and two men—the driver and stoker—narrowly escaped being blown into eternity, owing to the practical men to whom the safety of the boiler had been entrusted not understanding the signs of failure, of which there were ample indications before the boiler exploded. The barrel of the locomotive was affected by corrosive grooving at the longitudinal seams, as so many of these boilers with lap-jointed seams are found to be after they have been working some ten or a dozen years. Two or three days before the explosion occurred, a longitudinal fracture some two or three inches long was noticed through leakage which was taking place along the edge of the overlap. Notwithstanding, however, that this was an indication of the longitudinal grooving having fractured through the plate at this part, and that the boiler was actually on the verge of explosion, the boiler-smiths regarded it merely as they would have regarded a fracture from a rivet hole, which required a stop rivet only inserting at the end of the crack, and deliberately drilled and tapped four holes in the cracked portion, and applied a thin covering strip about $1\frac{1}{2}$in. wide, with four $\frac{5}{8}$in. set screws, to cover up the fracture and stop the leakage, with the result that upon getting up steam the plate ruptured along its whole length through the grooved part, opening out with sudden violence, and lifting the engine and tender bodily off the track.

The driver and stoker, who were both on the footplate when the explosion occurred, were badly injured and cut about the head and face, but both fortunately recovered from their injuries.

Everybody knows how many instances are on record of explosions of domestic boilers, which have occurred through our old acquaintance the "practical" plumber having been called in when the water connections have been frozen up, and who, after giving a confident assurance that it was "all right," has at once proceeded to light the kitchen fire, without first trying the connections, and by thus precipitating the explosion of the kitchen boiler has paid with his life the penalty of his ignorance.

Cases could be multiplied indefinitely did space permit, but sufficient, we trust, has been written to show how unwise it often is to rely too implicitly on the advice of so-called practical men in matters requiring careful thought and consideration, and especially in cases where the repair or alteration of any particular detail or part may affect the strength or stability of a structure as a whole.

SIR HENRY ROSCOE ON TECHNICAL EDUCATION.

Speaking at the Fifty-first Annual Meeting of the Yorkshire Union of Mechanics' Institutes, held at Castleford, near Pontefract, on the 20th instant, Sir Henry Roscoe, M.P., confirmed the opinion we have already expressed with regard to the desirability, in any national scheme on technical education, of avoiding a hard and fast system for universal adoption, preferring that the exact mode of carrying out the system should be left for each locality to decide for itself, with a view to meet each special industry and satisfy its peculiar requirements. Referring to the definition of technical instruction, Sir Henry said that what was aimed at was not an attempt to teach trades, but the principles, artistic and scientific, upon which trades depend. "The school," he said, "can teach how to make the best article and how to apply the principles which lie at the foundation of its manufacture. The workshop, on the other hand, teaches what the workshop alone can teach—how to produce the article most economically." This he took to be the essential difference between school teaching and workshop practice: the boy at school learns how to do the work well; the man in the shop must learn how to do it not only well but cheaply.

OPENING OF A SCHOOL OF HANDICRAFT AT TOYNBEE HALL.

The School and Guild of Handicraft which has been established in connection with Toynbee Hall, Whitechapel, was formally opened on Saturday afternoon last, by Sir W. Hart Dyke, M.P. The establishment includes a technical and art school, and a technical and art workshop, the two departments being mutually dependent. The plan is that the pupils of the school should work for the workshop, and that workmen of the workshop should instruct in the school, the best of the pupils being gradually drafted into the workshop. The number of pupils that can be accommodated at present is about 70, although some 160 applications have been already received. The workmen of the guild are to be paid small salaries as instructors, and will be expected to supplement such earnings by developing the workshop commercially on co-operative lines. Subscriptions to the amount of £200 a year are required for maintaining the school, which it is proposed to carry on for two years on trial. The guild of workmen will be self-supporting, and its accounts will be kept separately. If at the end of the two years of trial it can be proved from the results that the school and guild of handicraft can be worked on the lines indicated, the project will be attempted on a larger scale. To make the school a permanency it is estimated that an endowment of some £300 a year and the provision of proper class rooms will be necessary.

Censure of a Railway Company.—The Board of Trade report on the Hoylake railway collision, which occurred on Feb. 7th, 1887, is now published as a Parliamentary paper. Col. Rich, in the report, gives his opinion that the collision was the result of a total disregard by the company and by several of their officers and servants of the regulations under which this railway has been worked. He blames several officers for neglect of duty, and adds in most cases that they had been on duty for what seemed too long a time.

THE NATIONAL BOILER INSURANCE COMPANY.

The report of Mr. Hiller, the chief engineer for the above company, for the year 1887, just issued, contains much valuable information both for engine and boiler attendants, as well as for steam users and employers generally.

The report states that the collapses of furnace tubes which occurred during the past year in insured boilers were the result, almost without exception, of want of care or negligence, rather than want of knowledge, while no destructive explosion occurred amongst the boilers under the care of the company which inspection could have prevented. These facts, Mr. Hiller states, are a complete answer to the efforts of those desirous of subjecting steam users to Government supervision, and attention is called to the reduction in the number of explosions arising from steam boilers at the present time as compared with the number recorded a few years ago.

Comparing the five years ending December 31st, 1870, with the five years ending December 31st, 1887, it appears that whereas in the former period there were on the average 56·4 explosions, causing 71·6 deaths, in the latter there were only 35·8 explosions, causing 25·4 deaths, a reduction the more gratifying as the number of boilers in use has steadily increased. This improvement is, no doubt, due, as the report states, in great measure to the efficient service rendered by the leading boiler insurance companies, and to the greater appreciation by the large majority of boiler owners of the importance of periodical inspection.

Referring to the defunct Boiler Registry and Inspection Bill, introduced by Lord Stanley into the House of Lords in 1887, and to the General Committee for framing rules and regulations proposed in that bill, the report states that the establishment of such a committee must prove most harassing to steam users, and that any system of compulsory inspection would be attended with so many practical difficulties, and involve steam-boiler owners in such serious inconvenience and expense, that it is most undesirable. As an alternative to compulsory inspection, it is advocated that all actual explosions should be fully investigated under the powers that already exist, and any boiler owner proved guilty of negligence or recklessness should be dealt with accordingly.

Steam users, it is suggested, should be carefully on their guard with respect to any further attempts at legislation, and should insist that the faults and negligence of a small minority should not be visited upon and subject the majority to unnecessary restrictions; and it is urged that the interference of any Government department, either in arranging rules and regulations or directing inspections, should be strenuously resisted.

DECK MACHINERY AND HIGH-PRESSURE STEAM.

With the advent of the triple-expansion engine, and the common use of steam of double the pressure usually employed in the compound marine engines, there is gradually cropping up minor questions of importance in connection with the equipment of our steamships.

No doubt it is an exceptional case when a steam vessel does not have an auxiliary, or donkey boiler, for the specific purpose of providing steam to the steering gear, windlass, and winches; and it is not compulsory to carry so high a pressure of steam in an auxiliary as in a main boiler. Still there are occasions when resort has to be made to the main boilers for steam to work the deck machinery, and with the steam winches, windlasses, and steering gears, as hitherto generally designed, it is necessary to reduce the pressure of the steam, on its way from the main boiler to the deck machinery, by means of a reducing valve. If, however, unfortunately, the reducing valve should prove faulty, as many do, too great a pressure of steam may be passed, and a serious accident, or at least an untoward breakdown of a windlass, steering gear, or winch occur.

The question is thus raised—Why not make all deck machinery of sufficient strength to work with the same pressure of steam as the main engines?

Probably it may be argued that a considerable increase in the weight of the machinery would result, and no doubt some increase would be necessary, but we question whether it would be very great, especially if the principle adopted in the compound marine engines was applied to the winches, &c. Already a move has been made in this direction, and a steamer, built at Sunderland, has been equipped with compound steam winches. The working pressure of the steam supplied to the high-pressure cylinders is 150lb. per square inch, and the diameters of the cylinders are respectively 6½in. and 9in. The exhaust steam passes to a condenser placed in the donkey stokehole, and is utilised for feed-water for the donkey boiler, as in the ordinary marine engines. There is also the advantage of no exhaust steam escaping on deck, to the discomfort of the cargo men. The winches were manufactured by Messrs. Wigham and Co., of the South Hylton Engineworks.

As a set-off against the increased weight of the winches, windlass, &c., there would be in each instance a saving in the weight of the donkey boiler and in the fuel consumed. Further, it would be more frequently found practicable to have the donkey boiler, owing to its small size, placed on deck, instead of in a recess off the boiler space, thus leading to a saving in copper piping, and obviating to a large extent the condensation of steam on its way from the boiler to the winches.

MECHANICAL GLASS-BLOWING.

Some important improvements in the mode of manufacturing glass bottles have recently been effected by Mr. Ashley, of Messrs. Sykes, Mackay, and Co., Castleford, Yorkshire, by which the old exhausting method of blowing glass bottles by hand is superseded, the moulding being effected mechanically, and the blowing by means of compressed air.

The apparatus by which the operations are mechanically performed, and two of which have been erected, is termed a "repeating machine," and consists of a circular turntable, revolved by machinery around a central pillar. The whole apparatus is 7ft. diameter by 5ft. high over all, and at four points around its circumference are placed, at equal distances, four moulding machines. As the apparatus revolves each machine in turn passes before the "gatherer," who charges it with molten glass. The charged mould then passes on a quarter of a circle to the next point, where the mould is automatically turned upside down and the interior of the neck of the bottle is formed, the process of blowing being at the same time automatically commenced. Passing round another quarter of a circle, the mould reaches a point where it is closed, the air pressure put fully on, and the bottle completed. The third quarter of a circle brings the perfectly finished bottle to a point at which it is automatically discharged on to a carrier, by which it is conveyed to the annealing oven, in which it is placed by a boy. The cycle of operations will thus be seen to be as follows: While the first bottle is being automatically discharged a second bottle is being finished, a third one is being reversed and having its neck punched, while a fourth is being cast—that is, the molten metal is being filled into the mould. In practice the pair of automatic repeating machines will be served by four hands—namely, one gatherer, two machinemen (one to each machine), and one boy to take the bottles off the conveyor from both machines. With regard to the saving to be effected by the mechanical process over the ordinary method of manual production, it is stated that the actual output of Messrs. Sykes's works before the introduction of the machinery was 280 gross of bottles per day of ten hours, while the actual capacity of the works is now 420 gross per day. There is also a very large saving in the cost of labour.

A STEAM LIFEBOAT.

For several years the committee of the Royal National Lifeboat Institution have been endeavouring to find a means of propelling lifeboats mechanically. In April, 1886, a special sub-committee was appointed to inquire fully into the question. This committee, after visiting the Liverpool International Exhibition, with a view to examining the various models of steam and other mechanically-propelled lifeboats exhibited there, and hearing the evidence of the lifeboat coxswains who had had the greatest experience in the help to be obtained by the employment of steamtugs in assisting to perform lifeboat services, regretfully reported that they were "unable to recommend the adoption of any pattern of steam lifeboat at present." The following May, nothing daunted by the lack of success in former endeavours, the committee of the institution offered gold and silver medals to competitors all over the world "for models or drawings of a mechanically-propelled lifeboat best adapted to meet the conditions under which lifeboats are called upon to perform their work." In response to this offer numerous models and drawings were received from all parts of Great Britain, the Continent, and even from the United States. These were submitted to Sir Frederick Bramwell, F.R.S., Sir Digby Murray, Bart., of the

Board of Trade, and Mr. John I. Thorneycroft, gentlemen well known for their knowledge of kindred matters, but in no way connected with the institution. These judges, after a careful examination of all the models and drawings which had been sent in, reported that not one of them was suited for the purpose for which it was intended. The committee, although disappointed at this termination of the competition, nevertheless still hoped that science might yet help them in this matter. At the beginning of the present year a model of a steam lifeboat was submitted to the institution by Messrs. R. and H. Green, shipbuilders, Blackwall, which, having passed through various modifications as the result of consultation with the committee and their professional officers, was accepted by the institution, and Messrs. Green have now been instructed to build, as an experiment, a steam lifeboat on the proposed principle. The new boat is to be 50ft. long, with 12ft. beam, and to be propelled by a turbine wheel, worked by an engine developing 170 H.P. Such a boat, if successful, will necessarily only be able to be used at a limited number of stations.

THE GLASGOW EXHIBITION.

FROM OUR SPECIAL CORRESPONDENT.

(Continued from page 294.)

To THE engineers in charge of steam engines, and the owners of them, some of the most useful exhibits are those of Messrs. Lancaster and Tonge, of Pendleton.

Their specialities consist of details applicable to an engine, or as a part of or addition thereto, and very useful they each are in their way. Take, for example, a piston. What is the use of an engine, especially in these days of high pressure, without a good tight piston—one that works smoothly with little friction, and is also steam tight? Of late years many devices have been adopted with these objects in view—some complicated and some plain, some resulting in a piece of mechanism that if taken to pieces would puzzle all the ingenuity of engineers to put together again, while others take so long that all the time available for overhauling is taken up by attending to the pistons, to the neglect of other important working parts.

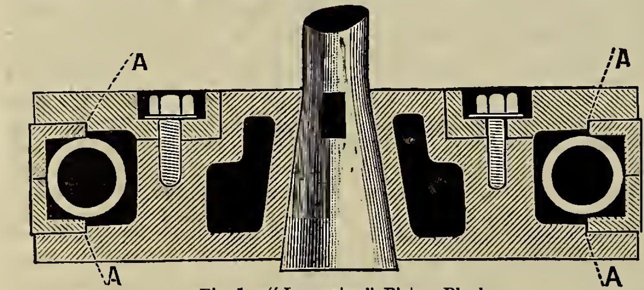

Fig. 1.—" Lancaster " Piston Block.

We think that this firm has entirely overcome all these difficulties, and have constructed a piston and spring at once adapted to the requirements for which they are intended. We have many opportunities of examining pistons, both new and old. There is scarcely a known make we have not had a look at, and so by comparison, and on their merits, we judge those before us.

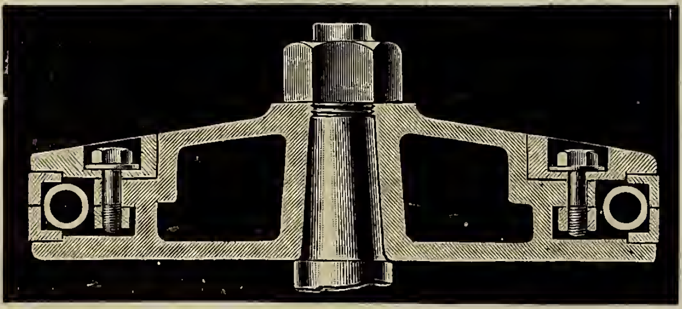

Fig. 2.—Marine Piston.

Until the last few years the prevailing idea was to press the packing ring out against the side of the cylinder by means of short springs, in order to make it steam-tight, and then scrape the bottom flange and junk ring to a fit on each side of the packing ring, and this plan is even yet adopted to a considerable extent. The pressure thus set up may be right or not. Sometimes these coach springs, as they are termed, break in the centre, and we have known them in marine engines wear themselves through the piston flange after rattling about.

This firm, while adapting their pistons to any and every description of cylinder, whether for pumping or steam, whether locomotive or stationary, make one specially suited for marine purposes. It has been tried, and has given great satisfaction. One great feature is that the cylindrical spiral spring is straight, and under the latest ideas of making a piston steam-tight, it presses upwards and outwards uniformly without undue strain on any one part. The rings can thus be made of much lighter section than formerly, when they at times acted as a guide to the piston. The sides of cylinders now wear smooth and bright, and oval ones are not so much heard of. But that there are many cylinders far from being round is well known, and when they are not too far worn a good idea is to fit a new piston on what we call the new principle, which will adapt itself to the inequalities of the cylinder, or in case of boring out the cylinder the piston block and junk ring can be turned down on the steam edges, when with new spring and ring it can be again fitted with good results.

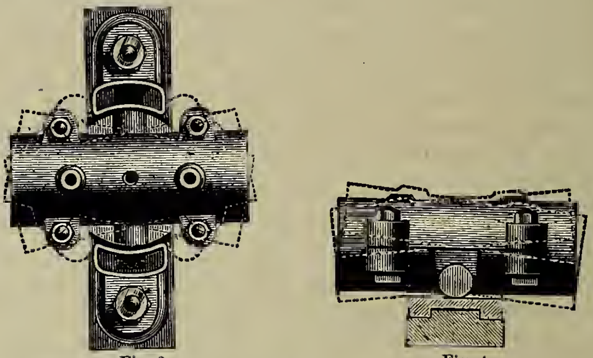

Fig. 3. Fig. 4.

Adjustable Bearings.

We also notice on this stand another useful fitting for all places where steam is used—in fact, an indispensable one where there are long ranges of pipes. We refer to a steam trap. Where there is not one of these, some means must of necessity be adopted to take away the condensed water. Drain cocks are at times used, but they require constant attendance, otherwise water would accumulate and cause damage.

In marine work steam traps are not fitted as a rule—nothing but the ordinary drain for all parts; but here engineers are always at hand, and it is only at the commencement of a voyage that there is any water to be drained away.

It is, however, sometimes held that water lodges in the pipes of a steamboat, and that it might pass into the cylinder if not taken away when the ship rolls; but this idea is not generally acted up to.

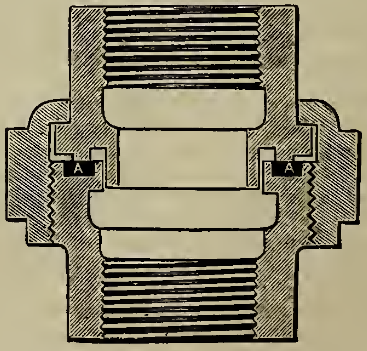

Fig. 5.—The American Union.

However, for mills, collieries, &c., a good trap should always be fitted, and one feature of the trap under review, and which was illustrated in our issue of Oct. 21st, 1887, is that it acts automatically; the only attention required is for cleaning. Strictly speaking, there are two traps, one for land and the other for marine purposes, the only difference being that the latter has a closed steam-tight cover, securely bolted, so that the water may be lifted up to the deck, where it can be used for baths, &c.

We have seen these traps at work, and can testify to their efficiency, while it may be mentioned that there are fifteen of them fixed to the range of pipes at the Exhibition.

This firm also show their adjustable bearings. Nearly all the shafting in the Exhibition is fitted with them, and also with the firm's patent "Vibration Lubricator." A reference to the illustrations in fig. 3 and 4 will explain how any little irregularity of alignment in the shafts, either horizontally or vertically, is compensated in the bearings.

A very simple device in the form of a screw coupling, for joining lengths of small pipes, called the Lancaster American Union, is also exhibited by this firm. As seen from the illustration, the pipes are screwed into each end of the union in the usual way adopted for receiving pipes into sockets, elbows, &c. The outer side of one half is also screwed, and a nut with an inside flange, which acts against a collar on the other half, is tightened up to make the joint. The inside faces consist of the turned edge of the union itself on the one side, and a finished patent metal face, AA, let into the union on the other. The joint is thus quickly made, needing no bolts, packing, or other of the usual requisites for joining pipes.

ON CAST IRON FOR MECHANICAL PURPOSES.—II.*

(Continued from page 298.)

The condition in which carbon exists in cast iron is not only determined by the temperature at which fusion has been effected, but also by the circumstances under which the iron has solidified. Rapid solidification favours the retention of carbon in the combined state, and by this means it is possible to convert grey cast iron, if only slightly siliceous, into iron that is perfectly white. This is the principle which governs chilling.

All grey pigs do not chill, and those resist this alteration most which contain most silicon, and those chill best which have a mottled texture.

After carbon, silicon is the most useful ingredient in cast iron, and it is always present in proportions varying from 0·2 per cent up to 30 per cent in ferro-silicon. Silicon requires a very high temperature for its reduction, and is more abundant in hot-blast than in cold-blast iron.

The author treats of silicon at considerable length, and calls attention to the efforts which have been recently made to rehabilitate silicon, and to show that provided the silicon present does not exceed a definite amount, that, far from reducing the strength of the iron, it serves to increase it. The author discusses the researches of Mr. Riley, Mr. Stead, Mr. Wood, and Mr. Turner on this subject, and gives an abstract of the experiments made by the latter; but he considers that the results obtained were due more to the relative purity of the irons used and their slight carburisation than to the amount of silicon contained in them.

The characteristic of manganese is to dissolve graphite and to increase the amount of combined carbon. It also augments the faculty for chilling; but in an iron containing 3·5 to 3·8 per cent of carbon (which amount of carbon is always accompanied by 1 to $1\frac{1}{2}$ per cent of silicon) manganese dissolves very little graphite unless present in larger quantity than $\frac{1}{2}$ to 1 per cent. The effect of the simultaneous presence of manganese and silicon is undoubtedly reduced by their combining together and forming a distinct alloy dissolved in the iron. Thus there are examples of iron containing 6·5 per cent of silicon, 7 per cent of manganese, and 3·25 per cent of carbon, which chill only very slightly. Manganese and silicon may therefore be considered as antagonistic, and either may serve to correct an excess of the other.

As manganese tends to dissolve graphitic carbon, it ought to harden the iron to which it is added and to increase the strength, provided that it is not added in more than sufficient amount to bring the graphite and combined carbon to the best proportions.

Phosphorus, like manganese, gives fluidity to iron without sensibly lowering its melting point. Experiments have shown that 0·4 per cent of phosphorus renders iron brittle, but this influence is not felt until the amount of phosphorus present exceeds 0·2 per cent, because some of the iron formerly reported to be the best for artillery in France (*e.g.*, that of Bandiat and of Pont-Nau, in the Landes) contains phosphorus to this extent. Phosphorus hardens iron and tends to make it white, not only by its action on the condition of the carbon, but also directly.

Sulphur dissolves in iron to an unlimited extent, until the iron passes into the condition of sulphuret of iron. Its action is always noxious. It increases the fluidity of the iron, but makes it set quickly, with a great deal of "draw"; it gives a dull, pale grain, and makes the iron spongy and brittle. There are few ores or fuels which do not contain sulphur, and the only way to prevent it getting into the iron is to use a basic flux. Without being completely incompatible with carbon, sulphur diminishes the affinity of iron for it. A very sulphurous iron is never rich in carbon, and, *vice versâ*, a very graphitical iron is never rich in sulphur.

According to the experiment of Mr. Caron, metallic manganese, by simple fusion with cast iron, deprives it of a large portion of its sulphur, and Mr. Ponsard asserts that 80 to 90 per cent of the sulphur may be got rid of by stirring ferro-manganese into the ladle at the moment of running. The sulphur passes into the slag, 2·6 parts of manganese being required to 1 of sulphur.

All the experiments are discussed at length, and the author summarises his results as follows:—

1. Ordinary grey pig may be much improved by partially decarburising it by mixing it with steel (or even white iron) in quantities just sufficient to attain that mottled condition which gives the greatest strength. The improvement in strength must, however, be obtained at the expense of softness.
2. Hematite can be improved much more than phosphoric pig.
3. For an equal percentage of increase in strength phosphoric pig is much more hardened than hematite.
4. The addition of spiegeleisen either to the hematite or phosphoric pig is prejudicial to the resistance to tension and impact, but by it the resistance to bending may be slightly improved.
5. The addition of ferro-silicon to either kind of pig lowers the resistance to tension, and is very prejudicial to the resistance to impact, but it may slightly raise the resistance to bending.
6. Ferro-silicon has the advantage of considerably softening the iron to which it is added, and may in many cases be very usefully employed for producing this result, but its use for the purpose of bringing white iron back from No. V. or No. VI. to No. III. or No. IV. is not, in the author's opinion, to be recommended.

W. P.

FORCED DRAUGHT.

In an article on the commercial value of forced draught, *The Engineer* states that the cost of working a steamship, and the difference between that cost and her earnings, depends on numerous and complex conditions; and her coal bills are by no means the largest and most influential items of expenditure. Some engineers hold that even if coal be used a little more wastefully with forced draught than without it, the economical efficiency of the whole ship as a profit-earning machine will be augmented; because smaller or fewer boilers will be needed, and so space is saved for carrying cargo. The first cost of the boilers will be less, and their dead weight, and that of the water in them, being less, a further addition is made to the cargo capacity of the ship. This is a reasonable string of arguments, and the only answer is that boilers for forced draught, with the requisite blowing machinery, will cost as much or more to begin with than the normal boilers, and that the cost of repairs must be very heavy; so that we may perhaps take as true, that unless the air is sent in the ashpits and furnaces through wind trunks in some way, the boilers will not last. But if this be a fact, then the forced draught apparatus becomes complex and expensive, and is subject itself to wear and tear. A furnace cannot be worked with forced draught in this way unless means are provided for automatically shutting off the air supply whenever the door is opened, or else the pressure must be very small; for were it otherwise, as there is a *plenum* in the furnace, the moment the door is opened the flames and smoke would leap into the stokehole. It is of course quite practicable to get over these and similar troubles; but the question is, at what cost? This is the point to which the whole subject always returns, deal with it as we may. This is the point, too, on which inventors are quite silent. Until data on this question are available a few experimental sets of apparatus may be used here and there, but no mark will be made on the great commercial interests of our country. Forced draught has its uses, but these must be carefully distinguished from economies. In a fast passenger steamer, for example, making short voyages, such as the Liverpool and Isle of Man boats, a system may answer admirably which would be intolerable on board a cargo boat steaming at ten knots. The Ireland, one of the fastest passenger steamers in the world, uses salt water in her boilers, jet condensers, and 35lb. pressure. There were circumstances which dictated the adoption of this old-fashioned system as the best, one being the practical impossibility of getting in a sufficiently large low-pressure cylinder had compound engines been used. But no one attempts to maintain that because the Ireland has been a conspicuous success all paddle engines should be built on the same plan; and what holds true in this way of the machinery of the Ireland must hold true of forced draught until proof positive in the shape of trustworthy and complete figures is available to show how it answers commercially.

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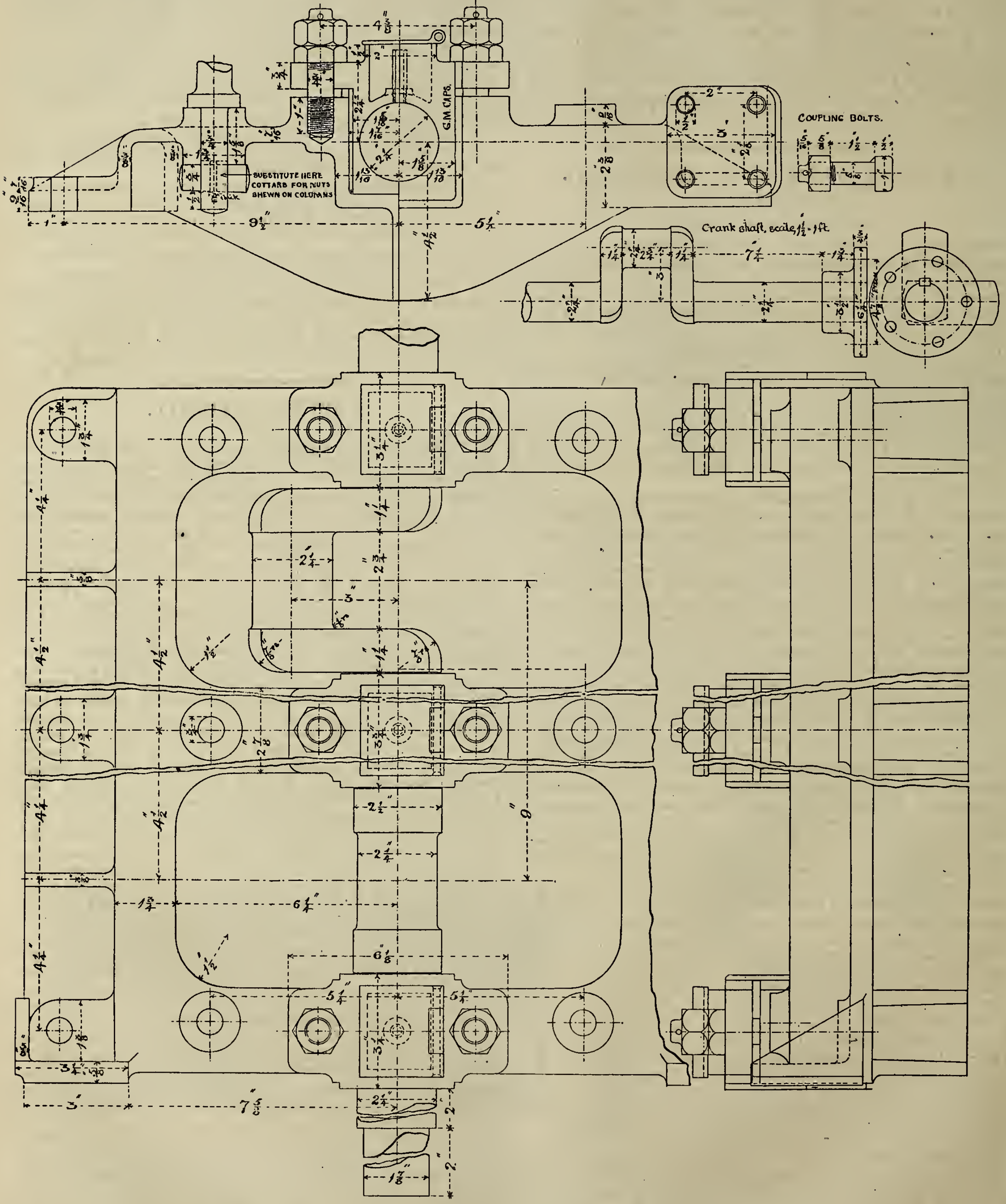
* Foreign Abstracts, Civil Engineers.

WORKING DRAWINGS.

LAUNCH ENGINES.—V. Details of Engine Bed and Crank Shaft.

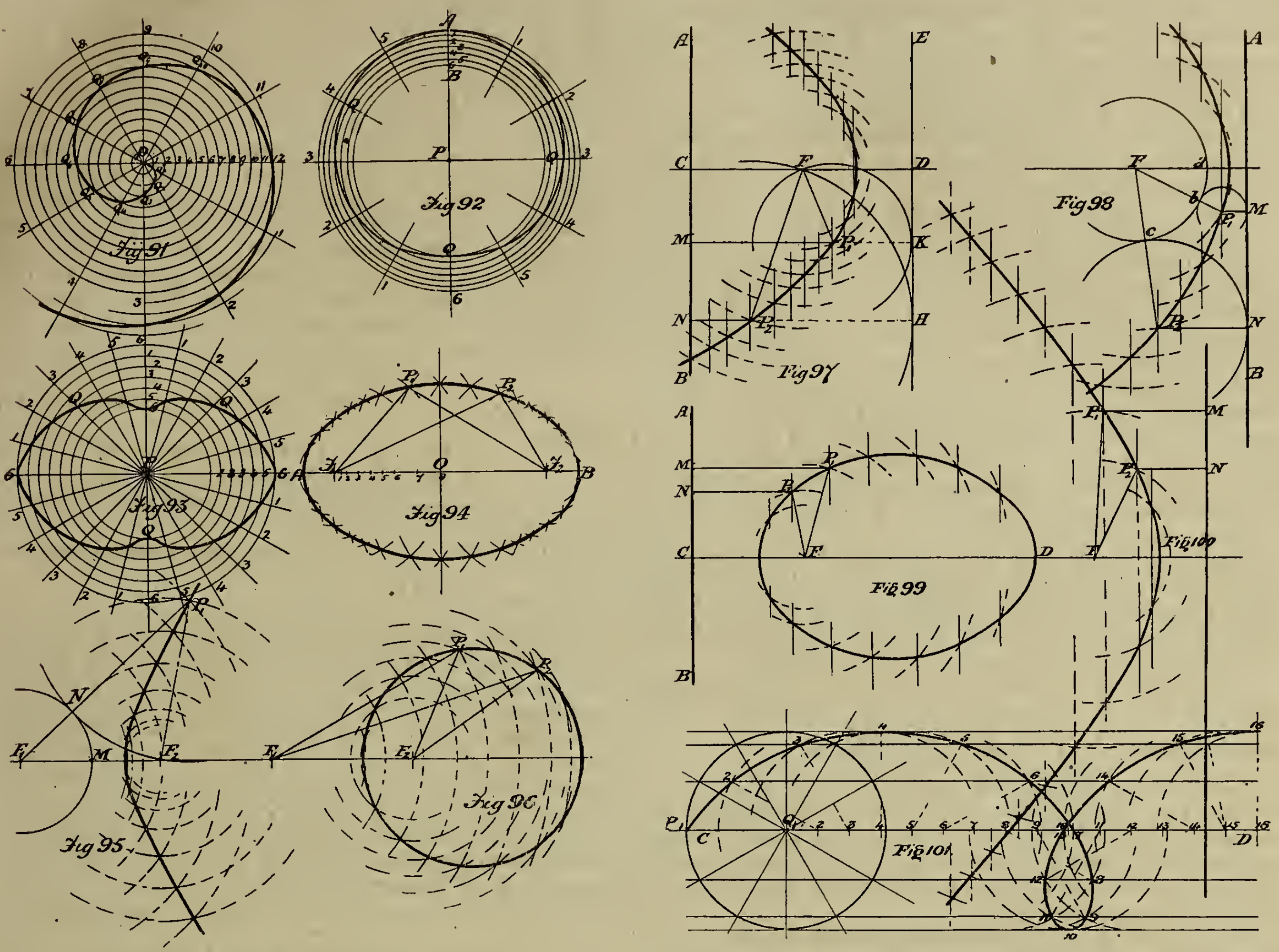
SCALE, 3in. = 1ft.


G.M. CAPS.
SUBSTITUTE HERE COTTARS FOR NUTS SHEWN ON COLUMNS
COUPLING BOLTS.
Crank shaft, scale 1½ - 1ft.

THE above is the fifth of our series of working drawings illustrating a launch engine, and represents to scale the engine bed and crank shaft. The previous article in the series appeared on April 27th. Our next sheet of drawings will represent the boiler.

LESSONS IN MECHANICAL DRAWING.—XVIII.

By Prof. A. MacLay, B.Sc., C.E.



LOCI (*continued*).—POINT PATHS.

Exercises.

Ex. 83, Fig. 91.—A point Q moves round about a fixed point P, and at the same time moves from it uniformly at the rate of 2in. per revolution. Show its path while it revolves one and a half times.

Construction : With P as centre and radius 2in., describe a circle. Divide any radius of this circle and its circumference into the same number of equal parts, say twelve (as explained in a previous lesson, this division of the circle is, like that into four and eight, very convenient, since it can be got at once by simply using the T and set squares).

Through the points on the radius draw concentric circles from P as centre, and through the points on the circumference draw radial lines. Then beginning at centre P trace a spiral curve passing through the intersections of circles 1, 2, 3, &c., with the radii 1, 2, 3, &c., respectively. For the third half-turn, extend the number of circles as shown in the figure, and trace the continuation of the curve in the same manner as in the first part.

Ex. 84, Figs. 92 and 93.—A point Q keeps moving round a fixed point P, and at the same time oscillates between a maximum and minimum distance from it.

In fig. 92 the point passes through the maximum and minimum distance of its range once, and in fig. 93 twice during each revolution.

In fig. 92 the range of motion is between 1ft. and 1ft. 5in. Draw to a scale of $\frac{1}{8}$. With centre P and radii PA = 1ft. 5in. and PB = 1ft., describe circles. Divide the circumference of the outer circle into twelve as in the last exercise, and the distance AB into six equal parts—into six, because in one-twelfth of a revolution the point Q will have come in towards or gone out from the centre one-sixth of its range. Then through the intersections of radials 1, 2, 3, &c., with circles 1, 2, 3, &c. respectively, trace the eccentric path of the point as shown in the figure.

In fig. 93 the range of the motion is between 8½in. and 1ft. 4½in. Draw to the same scale as the last figure. In this case, for greater accuracy, divide the circumference into twenty-four equal parts, as the range will only have one-fourth that number of divisions, viz., six. Otherwise, proceed as in the last problem, and as shown in the figure.

Ex. 85, Fig. 94.—A point P moves so that the *sum* of its distances from two fixed points, F_1 and F_2, remains the same throughout the motion. Otherwise expressed, the condition is that for any two points P_1 and P_2 on the curve, $P_1F_1 + P_1F_2 = P_2F_1 + P_2F_2 = \Sigma$.

This happens to be one of the properties of the ellipse, so that the construction which follows is one of the methods of describing that figure.

In fig. 94 F_1 and F_2 are two points 2¼in. apart, and Σ, the sum of the distances of any point from them, is 3in.

Construction : Draw a line through F_1F_2, and bisect it at O. Make $OA = OB = \frac{\Sigma}{2} = 1\frac{1}{2}$in. Divide OF_1 or OF_2 into a number of parts, as shown at 1, 2, 3, &c., in the figure. Then with F_1 and F_2 as centres, radii A1 and B1, A2 and B2, &c., respectively describe intersecting arcs of circles. Thus, for example, to obtain the point P_1, with radius A7 and centre

F_1, draw an arc, and with radius B7 and centre F_2 draw another arc intersecting the first at P_1. In the same manner find as many points as are necessary to trace the elliptic curve accurately throughout.

Ex. 86, Fig. 95.—A point P moves so that the *difference* of its distances from two fixed points F_1 and F_2 remains constant, or so that $P_1F_1 - P_1F_2 = P_2F_1 - P_2F_2 = \triangle$, P_1 and P_2 being any two points on the curve.

This is one of the properties of the curve called the "Hyperbola." The constructions which follow may therefore be used as methods of drawing that curve. In fig. 95 the distance F_1F_2 is $1\frac{1}{2}$in. and the constant difference $\triangle = \frac{3}{4}$in. First obtain a number of pairs of lengths which differ by $\frac{3}{4}$in., and from F_1 and F_2 draw intersecting arcs, through which trace the hyperbolic curve. Or the construction may be made in another way, for the problem resolves itself into that of Ex. 79, viz., that of finding the locus of the centres of all the circles, which touch a given circle and pass through a given point; the given circle in this case being that drawn from one of the fixed points as centre (F_1 in the fig.) with radius $\triangle$. For if from any point—*e.g.*, P_1 on the curve—we draw lines joining it with F_1 and F_2, and if from F_1 we draw a circle of radius equal to the difference of P_1F_1 and P_1F_2, then P_1N must be equal to P_1F_2. The curve is therefore the path of a point which moves equidistantly between the circle NM and the point F_2.

The construction may thus be—With F_1 as centre and radius equal to the common difference of the distances from F_1 and F_2, describe a circle. Then proceed as in Ex. 79, to find the path of a point which moves equidistantly from the circle NM and the point F_2, and as shown in fig. 95.

Ex. 87, Fig. 96.—A point P moves so that its distance from one fixed point F_1 is a constant fraction of its distance from a second fixed point F_2, or that $\frac{P_1F_1}{P_1F_2} = \frac{P_2F_1}{P_2F_2} = \rho$

In fig. 87 the distance F_1F_2 is $1\frac{1}{2}$in. and $\rho = \frac{11}{6}$.

First find a series of distances in the desired proportion as explained in fig. 86 A (Lesson XVII.), and with pairs of these as radii, from F_1 and F_2 as centres respectively, draw intersecting arcs as shown in fig. 96. Then trace the required curve through these intersections.

Ex. 88, Fig. 97.—A point moves so that the *sum* of its distances from a fixed point and straight line is constant, or as it may be otherwise expressed, that if r be the distance of any point on the curve from the fixed point, and p the length of the perpendicular from it upon the straight line, the condition is that $r_1 + p_1 = r + p_n = \Sigma$.

In fig. 97 the fixed point F is $1\frac{1}{2}$in. distant from the line AB, and $\Sigma = 2\frac{3}{4}$in. Draw the path of the point which moves, according to the foregoing conditions, about F and AB. Make CD $= 2\frac{3}{4}$in. and CF $= 1\frac{1}{2}$in. To find the position of any point such as P_1, take two distances, P_1M and P_1K, such that $P_1M + P_1K = \Sigma = 2\frac{3}{4}$in. At the distance P_1M draw a parallel to AB, and with P_1K as radius, F as centre, draw an arc, intersecting the parallel at P_1. In the same way find a sufficient number of points on the parabolic curve to be able to trace it, as shown in the figure.

This problem is the same, in another form, as that of Ex. 77, fig. 87, for if a perpendicular EH be drawn at D to the line CD, it will be observed that the perpendicular from any point on the curve to the line EDH is always equal to its distance from F, for the horizontal MK through P_1 is equal in length to CD, therefore equal to Σ. Thus P_1F must be equal to P_1K, and the locus is thus that of all points equidistant from the point F and the line EH—a parabola. The construction may therefore be the same as that in Ex. 77 and fig. 87 (Lesson XVII.), the line EH in fig. 97 being taken for YY in fig. 87.

Ex. 89, Fig. 98.—A point moves so that the *difference* of its distances from a fixed point and straight line is constant. As in the previous case the path may be drawn in two ways, (1) Find a number of pairs of lines which have a common difference in length, and by intersecting parallels to the straight line and concentric arcs from the fixed point as centre, with these as distances, find a number of points through which to trace the curve. (2) Draw with the fixed point as centre, a circle of radius equal to the common difference, and find the path of a point which moves equidistantly between that circle and the fixed straight line. Thus in fig. 98 let F be a point $1\frac{1}{4}$in. distant from a straight line AB, and let the common difference be $\frac{3}{4}$in.; *i.e.*, let $P_1F - P_1M = P_2F - P_2N = \triangle = \frac{3}{4}$.

With F as centre, radius $\triangle$ describe the circle *abc*. Then proceed as in Ex. 78, fig. 88, to find the locus of all points equidistant from the circle *abc* and the straight line AB.

Ex. 90, Figs. 99 and 100.—A point moves so that the ratio of its distance from some fixed point to that from some fixed straight line is constant. Or otherwise expressed, let p be the perpendicular distance of any part P from a straight line AB, and r its distance from a fixed point F; then the condition is that

$$\frac{r_1}{p_1} = \frac{r_n}{p_n} = \rho$$

There are two important curves corresponding to this condition.

(1) When r is less than p or $\rho < 1$.
(2) When r is greater than p or $\rho > 1$.

The curve from condition (1) is an ellipse, that from (2) a hyperbola.

(1) In fig. 99 F is a point $1\frac{1}{4}$in. distant from a straight line AB, $\rho = \frac{r}{p} = \frac{11}{17}$.

First find a number of pairs of lines in that proportion by the construction which was shown in fig. 86A last lesson; then at the longer of each pair of distances draw parallels to the line AB, and with the corresponding shorter distance of each pair as radius and F as centre, cut the parallel by an intersecting arc, as shown in fig. 99. A curve traced through these intersections will show the elliptic path of a point moving according to the given conditions.

(2) In fig. 100, the fixed point F is taken at the same distance from the straight line, but the fraction representing the ratio of the distances is inverted, viz., $\frac{17}{11}$ instead of $\frac{11}{17}$; *i.e.*, $\rho = \frac{r}{p} = \frac{17}{11}$. Proceed as in (1) to find a series of pairs of lines in that proportion, and by parallel lines and concentric arcs obtain as many points as are necessary for tracing the hyperbolic curve shown in fig. 100.

ENGINES OF H.M. CRUISER "AURORA."

The engines of the "Aurora," which have been supplied by Messrs. Thompson, Clyde Bank, are of the horizontal triple-expansion type driving twin screws. The cylinders measure in diameter 36in. in the case of the high pressure, 51in. intermediate, 78in. low-pressure cylinders, each having a stroke of $3\frac{1}{2}$ft., while the steam pressure is 130lb. to the square inch. The engines, it may be remarked, are unusually light, all the working parts being made of ingot steel and the principal castings of cast steel. The largest of the latter is the bedplate, which weighs about 6 tons, and was supplied by the Steel Company of Scotland. The main condensers have a cooling surface of 12,500 square feet, supplied with circulating water by four 14in. centrifugal pumps. Two of these only are for constant working. There has also been fitted one condenser having a total cooling surface of 617 square feet, into which all the auxiliary engines throughout the ship exhaust.

It has been found necessary in the high piston speeds now adopted to introduce an arrangement for regulating and assisting some of the reciprocating parts of the engine. In the engines of the "Aurora" an appliance has been fixed on the intermediate and low-pressure valve spindles for assisting the return stroke of the valves, so that the strain is taken off the eccentrics. The arrangement consists of a cylinder of 4in. diameter, into which steam is admitted, its admission and "cut-off" being controlled by a valve, which derives its motion from a lever attached to the valve spindle, and so fixed that the admission of steam is arranged to take place a little before the end of the valve travel, thereby cushioning the force of the blow, and assisting the return motion of the valve, and doing the work directly on the valve instead of doing it through the eccentric.

The crank and propeller shafts are 14¼in. in diameter, and the intermediate shaft is 13¼in. in diameter, and all have a 7in. central hole in them. They were supplied by Messrs. W. Beardmore and Co., Glasgow. The propellers are 14ft. 6in. in diameter, and have three blades each, with a total surface of 60 square feet. They are made of gun-metal.

The boilers, which are four in number and double-ended, are made of steel. They are 14ft. 8¼in. mean diameter, and 16ft. 6in. long. There are in all twenty-four furnaces, with a total fire-grate surface of 455 square feet. The tubes are 2½in. external diameter, the total tube surface being 13,872 square feet, and the total heating surface 15,832 square feet. The air for forced draught is supplied on the closed stokehold principle, there being eight double-breasted fans. There are two main feed pumps and two auxiliary feed pumps of Admiralty pattern placed in the stokehold for feeding the boilers. The results of the trials are that the vessel made a speed of 17·25 knots, and indicated 5,670 H.P.—*Engineering.*

THE HISTORY OF THE STEAM HAMMER.*

The invention of the direct-acting hammer dates from the year 1840. Struck by the fact that the heaviest forge hammers in use were insufficient in size to forge or to weld the shafts and cranks which were required in the construction of steam engines, several engineers in France and in England, at the same time, conceived the idea of suspending a mass of wrought or cast iron from the piston rod of a vertical steam cylinder, this block of iron forming a hammer, which was to be raised by means of steam introduced under the piston, and was then to be allowed to fall back upon the piece to be forged, conveniently placed upon an anvil. It appeared to them that this arrangement would enable them to vary the weight of the hammer, and the height of its fall within limits much more extensive than the existing hammer permitted.

Among these engineers, two men of great ability, both driven by the same necessity—James Nasmyth, in England, and François Bourdon, in France—followed up this idea, each on his own account, without knowing what the other was thinking of. Both had in view the same object of forging the heavy pieces of marine engines of a power greater than any which had been built previously to that time.

Nasmyth made a simple sketch of his idea in his sketch book, while Bourdon, who was then chief engineer of the Creusot Works, made a detailed drawing of his steam hammer, which he executed in 1840, and for which MM. Schneider Brothers, proprietors of the Creusot Works, took a patent in their name, September 30, 1841. This design was shown to all the engineers who visited Creusot, and especially to MM. Mimeret, Bertrand, and Paulin, all three of them naval engineers, who were then in charge of the construction of marine engines which were being built for the State.

The sketch of Nasmyth's steam hammer bears the date of November 24, 1839, and it was also in 1839 that Bourdon had the idea of a direct-acting steam hammer, to which he gave the name of "Pilon," which the tool has retained to this day in France.

The sketch of Mr. Nasmyth was shown to Messrs. Humphries, Brunel, Guppy, and several other competent engineers, who approved the idea; but the marine engine for which the English engineer had specially conceived this idea, and fixed it on paper, was not built, and the invention remained on paper.

At this time—that is, in 1839—the idea of such a tool seemed so daring that the Schneiders hesitated for a long time before building one.

Toward the middle of 1840 MM. Eugene Schneider and Bourdon visited England in order to study and report on the best forge hammers there used, and it was during their visit to the Nasmyth Works that Mr. Gaskell, Mr. Nasmyth's associate—that gentleman being absent at that time—showed them the sketch of the hammer. This sketch, being still incomplete in its details, did not answer all Bourdon's ideas, and he presented some objections, spoke of the hammer which he had designed in France, and drew with a pencil a sketch showing how, on his part, he had arranged the new machine.

After his return to France, M. Schneider, struck by the same idea which had presented itself at the same time to two men of distinguished merit, resolved immediately to put into execution the Bourdon plan of 1839. This hammer had been at work successfully for fifteen months when, in April, 1842, Mr. Nasmyth, on passing through Creusot, paid a visit to M. Bourdon, who asked him if he had put into practice his idea of the steam hammer. Nasmyth answered that he was studying out the machine, and that he expected to build it very shortly. Bourdon showed him the design of the hammer, asking what he thought of the arrangements, and then invited him to walk into the shops and see it at work. When he saw it, Nasmyth stood still an instant, and then said to Bourdon: "I am delighted to see before my eyes what I have so long carried in my head."

After having seen the Bourdon hammer at work, Nasmyth returned to his sketch, and undertook the completion and execution of it. It must therefore be certainly admitted that the sight of the hammer at work at Creusot, and the confidence which Bourdon reposed in him by relating the difficulties encountered in working out the details of the machine, must certainly have fixed in Mr. Nasmyth's mind the idea which he had originally conceived.

The direct-acting hammer is thus really the invention of Bourdon, but, at the same time, it does not really detract from the merit of his contemporary, James Nasmyth.

The first direct-acting hammer built at Creusot had a weight of 2,500 kilogrammes and a fall of two metres. Since then these shops have built a great number of steam hammers applied to special work, and varying from time to time in form and dimensions.

In France the single-acting hammer is most generally used for forgings. In England the double-acting steam hammer has been employed, even for very large hammers, by many builders, such as Nasmyth, Wilson, and Thwaites. The last-named built for the Elswick Works of Sir William Armstrong a double-acting hammer of 35 tons; and a hammer, also double-acting, of 50 tons, for the Oboukoff Steelworks, near St. Petersburg.

In 1873, at the Vienna Exposition, there was shown a design for a 50-ton hammer built for the gun factory at Perm, in Russia.

In 1878, at the Paris Exposition, the Creusot Works showed a model in wood of an 80-ton hammer, which was then under construction in the shops. The design of this hammer was subsequently modified, and its power increased from 80 to 100 tons.

In 1878 the Naval Steelworks, at St. Chamond, France, built an 80-ton hammer, intended, like that at Creusot, to forge heavy guns and armour plates.

In 1885 the Société Cockerill, at Seraing, Belgium, built a 100-ton hammer intended for the Terni Steelworks in Italy.

In 1886 Marrel Brothers, at Rive de Gier (Loire), France, built two hammers, one of 50 and one of 100 tons.

The Bethlehem Ironworks, at Bethlehem, Pa., in the United States, are now building a 125-ton hammer intended to forge heavy shafts for marine engines and guns, armour plates, and other war material.

IMPROVEMENTS IN GAS BURNERS.

In the course of the address delivered by Mr. Charles Gardner, the President of the Gas Institute, at the recent annual meeting, he said, referring to the endeavours to cheapen and improve the supply of gas, that it was, perhaps, in the apparently simple and unimportant item of gas burners that the greatest progress has in late years been made. Looking back to the primitive iron burners, and comparing them with the carefully made burners of the present day, even of the same types, it may be easily seen that great improvements have been effected. Even these improved burners are left in the back ground when contrasted with the still more modern regenerative and incandescent types of burners, of which there are now numerous makes, all claiming to be the best, and all at least giving better results than ordinary burners. Whether absolute flames or refractory substances raised to high temperatures by the combustion of the gas without visible flames are the most advantageous means for obtaining the greatest amount of light from gas seems as yet doubtful; but the incandescent method possesses the advantage that it can be applied to poor gas, which would yield but little light with ordinary burners. Within the last few years, numerous incandescent burners have been introduced, which give great promise of excelling all ordinary flame burners in economy of consumption, although some difficulties have yet to be overcome before the application of the incandescent system can become general.

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* By C. Chomienne, in the American *Railroad Journal.*

When it was first introduced, the gas and air were required under considerable pressure—a condition which could not be generally provided for. This has now been overcome, and these burners can be used with both gas and air at ordinary pressures. Another difficulty is found in obtaining a material for the shield or mantle which will withstand the intense heat of the incandescent light, the most refractory materials, or their compounds, having a tendency to deteriorate after being exposed for a time to the high temperature. In order to obtain a large surface, these mantles or shields must be composed of filaments, or of the material in a fine state of division, which materially assists the action of the heat; and, on account of this, it does not seem that an incandescent mantle or shield has so far been produced that will not deteriorate. It is claimed that some of the new types of regenerative or incandescent burners will develop three times as much light as ordinary burners with the same consumption of gas; producing, in fact, more than ten candles illuminating power per cubic foot of gas consumed. He thought, however, that the actual results obtained from high-power burners in general had been somewhat over-estimated by calculating the intensity, without regard to the quantity, of the light obtained. In the case of electric lighting, the arc lights give an intensely brilliant centre of light, although, from its small size, its diffusive power is necessarily low; and, with incandescent electric lights, or with any light of high intensity, this appeared to him also to apply. He did not mean to infer that poor is preferable to rich gas, but he thought that the photometric values of high-power lights were liable to be misleading so far as regards their useful effect in lighting large spaces. High-power lights were also generally used with shades or reflectors which concentrated the light, so that a brilliant effect was obtained in a given direction, while the surrounding space was in comparative obscurity.

NATURAL GAS IN CHINA.

The following abstract of an account given by Baron Von Richtofen of natural gas wells in China is given in the United States consular reports by Charles Denby, United States consul at Peking. These wells are found in Sz'chwan, near a town called Tsz-lin-tsing. In an area of 27 li (9 miles) diameter salt wel's are found. To make a well the Chinese use a long and elastic bamboo pole, supported in the middle by a cross piece, a rope made by coupling the ends of long (not twisted) slices of bamboo, and an iron instrument which weighs 120 catties (catty = $1\frac{1}{3}$lb.). The rope is fastened on the thin end of the pole, and the iron on the end of the rope. A slight up and down motion of the thick end of the pole makes the iron hop and bore a vertical hole with its broad, sharpened edge. The ground to be perforated consists chiefly of sandstone and clay. When a portion of the rock is mashed, clear water is poured into the hole, a long bamboo tube, with a valve in the bottom, is lowered, and the turbid water raised to the top. Pipes of cypress wood are rammed in to protect the sides of the bored hole, and to prevent the water contained in the surrounding ground from getting access to the well; the pipes are attached to each other at the ends with nails, hemp, and tung oil. The inner width of the pipes is about five inches. As the work proceeds the pipes are rammed deeper, and a new one attached on the top; the rope, too, is made longer. At a depth varying from 70 to 100 chang (700 to 1,000 feet), the brine is struck, and the well is fit for use. The brine is raised to the top, through long bamboo tubes, and bamboo ropes, as described, by means of a horse whim, and then carried to large pans for evaporation, or led to them through bamboo pipes. Besides these wells there are others, which are bored to the depth of from 1,800 to 2,000 feet. At that distance below the surface petroleum is struck. Immediately on reaching it an inflammatory gas escapes with great violence. Work is now stopped, and a wooden cap fastened over the mouth of the pit, perforated by several rows of round holes. In each of them a bamboo pipe is inserted, and through these the gas is led under the evaporation pans. The pipes ramify, and on each end a tapering mouthpiece, terminating in a small aperture, is attached. The gas is then used for evaporating the brine. The enterprising spirit which induced the Chinese to examine the ground at so great a depth is said to have had its origin in the drying up of a brine pit. The proprietor was in hopes of meeting brine at a greater depth, but found instead the gas. When the country was infested with rebels during the Taiping rebellion, they removed the cap from one of the gas pits and set fire to it. Since that time, or at least up to the time that Baron Richtofen wrote, a long column of fire rose from that pit, and it is considered nearly impossible to stop the flame. The gas pits and brine pits are owned separately by corporations. The owners are subjected to the control of the government. The government monopoly is in the hands of the "taotai," who resides at the place. The salt works of Tsz-lin-tsing yield considerable revenue to the government, and have besides enriched numerous proprietors, and given occupation to a numerous population. The number of "fire pits" is 24, and the salt pits are innumerable. Some of them do not enjoy the advantages of gas. The brine is evaporated with grass and wood.

CORRESPONDENCE.

We do not hold ourselves responsible for the opinions of our Correspondents.

EXPANSION GEAR.

To the Editor of "The Practical Engineer."

Sir,—The statement in Messrs. T. McCulloch and Son's letter in your issue of the 15th instant, while correct in the main, does not convey the whole truth. For some time we were the sole licensees in England for the Proell expansion gear, and still supply it when required to do so. But having, in the early part of last year, brought out an expansion gear of our own, which possesses many advantages over the Proell gear, we terminated the engagement which gave us the exclusive license. We have a compound engine fitted with our patent expansion gear driving the electric light at the Glasgow Exhibition.—Yours, &c.,

Lincoln, June 19th. Robey and Co.

THE STEAM ENGINES AND BOILERS BILL.

To the Editor of "The Practical Engineer."

Sir,—Your correspondent "Ignorance" gives a few additional particulars of the boiler referred to in his previous letters. The statement that "the boiler was wasted away to one-third its original thickness along the bottom" is very indefinite, for if this wasting was entirely clear of the longitudinal seams, the reduced plate would only be about 10 per cent weaker than the longitudinal seams, and the boiler would retain nine-tenths of its original strength; whereas, if these seams were wasted to one-third of their original thickness, the boiler would only retain one-third of its original strength. It is not my intention to defend carelessness or recklessness on the part of boiler inspectors; but I cannot see how the object in view can be advanced by vague and misleading statements, more especially in this case, where they point to a different conclusion from that intended. As stated in a previous letter by "Ignorance," the attendant refused to work the boiler at the increased pressure, from which it may be inferred that he knew something about the defective condition of its bottom. If so, did he inform the first inspector, or give him any facilities for its examination? and if not, why not? In this case, the certificate would have merely been the guinea stamp; but unless it divided the responsibility between the attendant and the inspector, it would, in my opinion, have little value. The case points to another conclusion not mentioned by "Ignorance," viz., the readiness with which neglect or recklessness on the part of an inspector is brought to light. The fact of this boiler being condemned and taken out could scarcely be concealed from his employers, whose pecuniary responsibility, to say nothing of their reputation, would hardly permit them to condone conduct like this. Your correspondent is not well informed when he insinuates in his letter of May 14th, that the company in Mount Street, Manchester, is the only one which will refuse an inaccessible boiler; for I could show him that one of the largest, in point of numbers, have for some years been refusing about every tenth boiler for that reason. If your correspondent will refer to the annual report on the working of the Boiler Explosions Act of June 30th, 1887, which was noticed in your issues of September 23rd and October 24th, 1887, he will there find the companies commended for conducting their examinations in a satisfactory manner, notwithstanding the considerable difficulties experienced in getting proper facilities for these examinations.

This matter of facilities appears to be the greatest difficulty in the way of proper inspection, and it cannot be too widely known that an inspector can see no further through a brick wall, or even a thick crust of soot, than any other person.—Yours, &c.,

June 25th, 1888. Boiler.

WORKING OF STEAM ENGINE—IMPAIRED VACUUM.

To the Editor of "The Practical Engineer."

Sir,—Your correspondent, "A Young Engineer," who writes *re* above in *The Practical Engineer* of June 8th, is evidently labouring under the very common but erroneous impression that if the pressure on an engine piston is not within a few pounds of the boiler pressure, there is necessarily something wrong somewhere, and that the steam passages or ports are too small, or the steam is in some part or other obstructed. I have known large sums spent in putting in larger steam pipes, new side pipes to beam engines, larger valves, &c., and even new cylinders, with larger steam ports and passages to remedy this supposed defect, and all to no purpose; the simple explanation being that for the load on the engine, and the speed at which it was required to run, no greater pressure was necessary than that which was actually obtained on the piston; and indeed if the throttle valve had been lifted a little, and more steam thus admitted, the engines would have increased in speed and the governor balls would have swung out and shut the steam off again, or the engine would have run away. Hence the answer to "A Young Engineer's" question as to why with 100lb. pressure in his boiler he only gets 70lb. pressure in his H.P. cylinder may be simply that his engine does not require more than 70lb. for the work it is doing, and that any greater pressure would cause it to run too fast. He can, however, easily determine this for himself in a few minutes.

Of course, if he has a difficulty in driving the load on the engine at full speed, there is obstruction somewhere, which requires remedying; but if his engine is running full speed, with 70lb. on the H.P. piston, there is probably nothing the matter, and if he will just lift the throttle valve a little, to admit more steam, and he finds the engine at once increase its speed, he may rest satisfied that it is the throttle valve satisfactorily performing its required function in regulating and controlling the speed of the engine, which is the cause of the great disparity between the engine and boiler pressures. Indeed, if he will run the engine with a lighter load—*i.e.*, with a portion of the machinery standing, and the boiler pressure still 100lb.—he will find the governor balls act so as to still further reduce the initial pressure on the H.P. piston.

The difference between the vacuum obtained in his condenser and the effect on his low-pressure cylinder is a more serious matter. There is a clear loss here of at least 7lb. in the effect of the vacuum, which means, with this engine, a loss of nearly 120 indicated horse power, probably equal to eight or nine tons of coal per week, which ought to be saved. As the loss is in the cylinder, it should first be seen whether air is entering anywhere, through the gland and stuffing box of the piston rod, for instance. "A Young Engineer" should read the articles on "The Money Value of Vacuum"; "Bad Vacuum: Its Causes and Cure," &c., which have appeared in the columns of *The Practical Engineer* during the present year, and which will probably give him all the information he may require. If not, he had better write again, and I am sure there will be plenty amongst your readers who will be glad to help him, besides yours truly, MECHANICAL ENGINEER.

QUERIES AND REPLIES.

WEIGHT OF GRINDSTONE.—Will you or any of your readers kindly give me a rule for finding the weight of ordinary grindstones in use in machine shops, and say what would be the weight of a grindstone 7ft. in diameter and 14in. thick?—CONSTANT SUBSCRIBER.

Answer.—The following rule will probably be sufficiently accurate for your purpose: Square the diameter of the stone in feet, multiply by the thickness in feet, and add one-tenth; the result will be the weight in hundredweights. Applying it, for instance, to the case in point,

$7 \times 7 \times 1\frac{2}{12} = 57$, and $57 + 5{\cdot}7 = 62{\cdot}7$ cwts. EDITOR.

CLEANING AXLES AND BEARINGS.—What is the best way to thoroughly clean axles and bearings of grease? N.B.—The axles and bearings cannot be separated, and are difficult of access.—SANDY.

Answer.—Try lubricating with paraffin oil for a short time. A boiling solution of soda-ash (black ash) may be used to cleanse the parts externally.—ANTI-GREASE.

RIVET FURNACE.—Can any reader of your valuable paper give me some idea of an economical rivet-heating furnace for two stationary riveting machines?—P. H.

COPPER BOILER.—Could any reader inform me what would be the most suitable kind of copper boiler, with fire box, for 2½in. by 3½in. stroke horizontal engine, to be heated by a lamp or otherwise, and what would the dimensions be?—F. W. T.

CONCAVE CIRCULAR SAW.—Can any reader describe the use of a concave circular saw? It is supposed to be attached to the end of saw spindle outside of bench and driving pulleys.—H. C.

MACHINE FOR STAMPING NAILS.—Will one of your readers give me the name of a good firm to manufacture a special press for stamping out nails?—F. C.

THIN PLATES.—Can any of the readers of your practical and valuable paper inform me if it is possible to get thin sheets of iron or steel (say 20's gauge) as large as 8ft. 6in. by 4ft. 6in.? If so, where?—CHALKLINE.

SMOKE-CONSUMING FURNACE.—Can any of your readers give me the address of the makers of Thompson's smoke-consuming furnace?—J. E.

SETTING SLIDE VALVES.—Would any of your readers be good enough to explain the method of the setting of the valves of a common condensing marine engine (not compound)? There are two common expansion slide valves, with link motion between cylinders, fitted with hand gear. The cylinders are 24in. in diameter. and 2ft. stroke.—AMATEUR.

PITCH OF PROPELLER.—Can any of your readers inform me how to alter the pitch of a propeller? Suppose, for instance, a chief engineer receives orders to take the pitch of his propeller by measurement while the steamer is in dry dock, how should he proceed? A sketch would oblige.—PORT GLASGOW.

REMOVING BLACK JAPAN FROM STEEL.—Can any kind reader of your paper inform me as to the best way to remove black Japan varnish from steel?—SANDY.

CEMENT FOR INDIARUBBER.—What is the best way to cement rubber to steel?—SANDY.

TO CORRESPONDENTS.

VALVE SETTING.—In answer to "Basso," we may say that the subject of valve setting has been treated in a very simple and graphic manner at various times in our columns, and beg to refer him to the following numbers: June 17, 1887, page 222; October 14, 1887, pages 451 and 457; October 21, 1887, page 464; October 28, 1887, page 477; November 4, 1887, page 489; December 9, 1887, page 550; January 6, 1888, page 9; January 13, 1888, page 15. On referring to the above we think "Basso" will find all the information he requires.—EDITOR.

CASTING IRON ON BRASS.—In answer to "Snitcher," you certainly cannot run cast iron on to brass, as the melting point of cast iron is much higher than that of brass. The inverse operation is sometimes performed, as in case of pump rams, which frequently have a casing of brass run round a cast-iron plunger. If you want your cylinder to be brass lined, the lining must be fitted in after the cylinder is made.—EDITOR.

COMPRESSION OF ATMOSPHERE.—In answer to "Weekly Subscriber," Sheffield, we beg to say that your question is an absurdity. To speak of "compressing the atmosphere to a *power*" is simply nonsense.—EDITOR.

SPRING FOR MCNAUGHT INDICATOR.—In answer to "J. G.," Bingley, we should think you could get a spring for the indicator either at Mr. Casartelli's, Market Street, Manchester, or Messrs. Elliott's, instrument makers, Strand, London; or you might write to Messrs. McNaught's, Glasgow. They did supply them a short time ago, but whether they do now or not we cannot say.—EDITOR.

HOW TO BECOME A MARINE ENGINEER.—In answer to "Marine," we beg to say that a full answer to his inquiry will be found in our issue for March 9th last, page 119, under the heading of "To Intending Marine Engineers."—EDITOR.

MATHEMATICS FOR APPLIED MECHANICS. — "Apprentice Engineer," Aberdeen, will find full information as to the knowledge of mathematics required for the subject of Applied and Theoretical Mechanics in the Syllabus of the Science Examinations, which can be obtained from the Secretary, Science and Art Department, South Kensington, London. The price, we believe, is 3d. With regard to Euclid's Propositions—these are not poems, and you can't pick out a few isolated propositions and learn them off like so many verses. If you want to master Euclid, you must go straight through. No short cuts and no cramming.—EDITOR.

MISCELLANEA.

THE WELSH GOLD MINE.—A company has been formed to work Mr. Morgan's gold mine, at Dolgelly, North Wales. The capital of the company is to be £210,000, in £1 shares.

PRODUCTION OF ALUMINIUM.—Cowles's process for the production of aluminium from its ores by the direct action of an electric current of 5,000 amperes in an electric furnace has now become an industry Works have been started near Stoke.

A NEW CEMENT.—Mr. A. C. Hoare, formerly of Ceylon has introduced into Burmah, where extensive building operations are in progress, a new cement, which is said to be stronger than Portland, and to be applicable alike to masonry, metal, and wood work. The cement is applied hot, and sets in a few minutes.

LARGE REFLECTING TELESCOPE.—It is stated that Baron Albert Rothschild has purchased the largest mirror telescope constructed at Paris for 40,000 florins, and presented it to the Vienna Observatory. A gallery for it has also been built and endowed by the baron. The total cost of this scientific gift will amount to upwards of £8,000.

THE ENGLISH RACE.—At present the populations either speaking the English language or under the domination of English-speaking peoples number more than 318,298,000, or one-fourth of the population of the globe. The English-speaking races occupy one-fourth of the dry land of the earth, and own nearly two-thirds of the tonnage of the ships.

TORPEDO BOAT.—The Herreshoff Manufacturing Company of Bristol, R.I., have in hand a torpedo boat for the United States Government, 138ft. long. The craft will be propelled by twin screws 5ft. in diameter, driven by engines indicating collectively 1,800 H.P. The speed contracted for is 25 knots, but the Government promise a bonus for any excess over this amount, and it is stated that the builders expect to attain a speed of 28 knots.

SUNSHINE AND SHADE IN 1887.—From the report of the Astronomer Royal, it appears that the mean temperature for the year 1887 was 47·8 degrees, or 1·5 degree below the average of the preceding 46 years. The highest temperature was 92·2 degrees on July 4, and the lowest 15·5 degrees on January 2. The number of hours of bright sunshine was 1,401, or 190 above the average of the preceding ten years. The rainfall was 19·9 inches, being 4·8 inches below the average of the preceding 46 years.

THE FORESTS OF EUROPE.—The French Ministry of Agriculture has just issued some interesting statistics respecting the distribution of forests in Europe. The total area of Europe laid out in forests is set down at about 708,862 million acres; that is, about 18·7 per cent of the total area of Europe is forest land. In proportion to its total area Great Britain and Ireland has of all countries in Europe the least extent of forest, amounting to only 4 per cent of its surface. Denmark has 4·8 per cent; Portugal 5 per cent; Holland 7 per cent; France 17·7 per cent; Hungary 29 per cent; Norway 24 per cent; Russia in Europe, 37 per cent; and Sweden 39 per cent

The Most Powerful Light in the World.—The arc lamp in the St. Catherine's Lighthouse, on the Isle of Wight, is said to be the most powerful electrical light in the world, and equal to 60,000 candles. The carbon pencils have a diameter of 2½in., and the electric arc bridges a space of about ½in. between the carbon points. The lamp is of the Serrin-Berjot type and the dynamos by De Meritens, of Paris, while the engines to drive them are of the compound type, by Robey and Co., of Lincoln.

Castor Oil as a Lubricant.—The Italian Admiralty has recently carried out a series of experiments to test the respective worth of olive or resinous or castor oil for lubricating purposes in the Italian navy, and we understand it is decided that henceforth all the exposed parts of machinery are to be lubricated exclusively with castor oil. For the internal parts of the machines mineral oil will be used, and where olive oil is exceptionally employed the engineer must register the fact, and his reason for using it.

Exhibition at Cardiff.—The work of constructing buildings for the accommodation of a Trades Exhibition, which is to be held in Cardiff early in September, has been vigorously commenced. An open space, popularly known as the Ten Acre Field, has been inclosed, and a staff of carpenters and labourers are actively at work upon the main building. This section will cover a superficial area of 300ft. by 120ft. It takes the form of three connected wooden erections running side by side, each having a trio of avenues.

Threatened Strike of Colliers.—In South Wales a movement is rapidly spreading among the colliers to make a decisive stand in favour of reducing the working hours from twelve to eight per day. At a meeting of delegates, representing 20,000 colliers in the Rhondda Valley, it was unanimously resolved that the time had arrived when a decisive stand should be made for a reduction of the hours of labour and the curtailing of the production of coal, in view of securing better wages, and that all miners of South Wales and Monmouthshire be invited to co-operate. Similar resolutions have been passed by other delegate meetings, and it is feared that a general strike is imminent.

Woolwich and Enfield Gun Factories.—From a Parliamentary paper just published, it appears that the number of men employed at the gun factories at Woolwich and Enfield during the year ending February 29th last was as follows: In the carriage department, 2,107; in the Royal Laboratory, 6,691; in the Gun Factory, 2,043; and in the Small Arms Factory at Enfield, 2,019. Of this total of 12,860 hands, 224 were foremen, 48 timekeepers, 250 draughtsmen and writers, 2,790 engineers, fitters, forgers, and smiths, 178 boiler-makers and moulders, 377 carpenters and wheelwrights, 105 masons, bricklayers, and painters, 2,595 belonging to other subsidiary trades, 4,418 labourers, and the remainder were lads.

Manchester Ship Canal.—The works in connection with this undertaking are being vigorously proceeded with, and there are now 400 men at work in three large cuttings in connection with the Salford Dock, with three steam navvies, seven locomotives, and seven steam cranes. The dock will contain 26ft. of water, and already the full depth has been excavated in some places, and there will shortly be railway communication throughont the entire length of the canal. There are 1,000 men employed on the Mode Wheel, Barton, and Eccles section. Bridges are being built across the Irwell at Salford and Mode Wheel in connection with the Barton Railway, and a massive bridge spans the river for the purpose of forming a communication between the works and Cornbrook.

Electric Lights in Omnibuses.—A contrivance has recently been patented which permits the use of electric lamps in road cars, omnibuses, trams, &c. The electricity required is stored in a small box or receiver, which can easily be disposed of on the outside of the omnibus. A flexible wire connects this store box with the lamp, which is so constructed that the mere shifting of the lamp itself a few inches in the grooves of its fittings automatically connects the current and produces the light. A reverse motion extinguishes it. These portable storage boxes or accumulators are charged with electricity sufficient for two days. This contrivance has been used upon some fifty omnibuses and road cars in London, and negotiations are pending for permission to use this new lighting apparatus in the public vehicles plying in other populous centres.

The Value of Mechanical Drawing.—Referring to the importance of teaching drawing, Professor Huxley states that in his opinion there is no mode of exercising the faculty of accurate reproduction of that which is observed, no discipline which so readily tests error in these matters, as drawing properly taught. By that he does not mean artistic drawing, but rather the making of plans and sections, approaching geometrical rather than artistic drawing; and in his judgment, the child who has been taught to make an accurate elevation, plan, and section of a pint pot has had an admirable training in accuracy of eye and hand. Accuracy is the foundation of everything else, and instruction in artistic drawing is something which may be put off till a later stage. Nothing had struck him more in the course of his life than the loss which persons who are pursuing scientific knowledge of any kind sustain from the difficulties which arise because they never have been taught elementary drawing.

SELECTED PATENTS.

APPLICATIONS FOR LETTERS PATENT.

June 15th.

8756 Dredging Apparatus, J. Price, jun., Dublin.
8758 Power Machine, J. A. Forsyth and A. B. Coleman, Canada.
8761 Automatic Fog Signalling on Railways, J. Wilson, Ipswich.
8763 Sight-feed Lubricators, J. A. Morris and W. T. Hatch, Manchester.
8764 Fire Escape, J. Lane, Preston.
8765 Holders for Incandescent Lamps, W. Rowbotham and W. Fox, Manchester.
8772 Electrical Switches, W. Rowbotham and W. Fox, Manchester.
8778 Actuating Underground Engines, W. Carey, Bo'ness.
8783 Consolidating Scrap Metal, R. Evans, London.
8789 Automatic Regulator, G. Burgess, H. D. Ledward, and F. Burgess, London.
8790 Tap Unions, C. Darrah, J. Kay, and T. Jones, London.
8800 Circular Revolving Slide-rest, W. Lorenz, London.
8807 Couplings for Pipes, E. Edwards, London. (J. Feyrer and P. Thirion, France.)
8809 Electric Switches, H. H. Lake, Middlesex. (S. Bergmann, United States.)
8811 Scutching Machines, J. Rosicky, London.

June 16th.

8820 Slotting and Drilling Machine, J. Kay, Manchester.
8821 Fire Escapes, A. Neuhaus and C. Ascher, London.
8823 Candle-making Machines, J. M. Storrar, Glasgow.
8836 Electrical Switch, G. J. Philpott and G. H. Alderton, Brighton.
8841 Propelling and Steering Boats, F. O. Ferguson, Hammersmith.
8844 Manufacture of Steel, P. Evans, Liverpool.
8845 Screw Propellers, P. Evans, Liverpool.
8852 Consuming Smoke in Boiler Furnaces, J. E. Hall, London.
8854 Blowing Engines, C. J. Galloway and J. H. Beckwith, London.
8855 Fire Escapes, W. J. Edwards, London.

June 18th.

8871 Electrical Switches, J. I. Ryder, Derbyshire.
8876 Hydrocarbon Engines, R. Welford, North Hylton, Sunderland.
8883 Steam Traps, Sir W. Vavasour, Bart., London.
8884 Wheel Springs, Sir W. Vavasour, Bart., London.
8885 Motive-power Engines, T. Carter and T. Cooper, London.
8890 Steam Injectors, C. A. Day, London. (S. O. Johnson, United States.)—[Complete Specification.]
8905 Electric Batteries, H. Lahousse and Co. and C. Collé, London.
8912 Electric Meter for Recording Electricity, H. Raison, Battersea.
8918 Valve Nut Lock, A. M. Clark, London. (W. H. Vanwort and E. A. Devaw, United States).
8920 Electric Cable, J. G. Lorrain, London. (La Société d'Exploitation des Cables Electriques, système Berthoud-Borel et Compagnie, Switzerland.)

June 19th.

8925 Manufacture of Metals, R. P. Wilson, F. J. Wall, F. A. Thurston, T. L. Bibbins, and W. L. Flanagan, London.—[Complete Specification.]
8926 Steam Boilers, C. H. Twist, London.—[Complete Specification.]
8927 Machinery for the Manufacture of Metallic Tubes, R. E. P. Craven, Leeds.
8928 Metallic Tubes for Flues of Steam Boilers, R. E. P. Craven, Leeds.
8936 Ventilator, J. Lumsden, Glasgow.
8942 Feed-heating Apparatus for Steam Boilers, J. Howden, Glasgow.
8859 Gas-burner Regulators, F. Lux, Westminster.
8964 Valve Gear for Steam Engines, C. J. Galloway and J. H. Beckwith, London.
8969 Roller Bearings for Shafts and Axles, E. Edwards, London. (E. A. Schneider, Germany.)
8973 Treatment of Smoke, S. Elliott, Newbury.
8982 Liquid Meter, W. Key, London.
8983 Chucks, R. J. Pratt, Middlesex.—[Complete Specification.]
8985 Screw Propellers, S. J. Tucker, Liverpool.
8890 Motors, W. P. Thompson, Liverpool. (J. B. Erwin, United States.)—[Complete Specification.]
8994 Pumps, H. M. Close, London.—[Complete Specification.]

June 20th.

9001 Sewing Machines, C. Huelser, of the firm of Huelser and Co., London. (P Jansen, Belgium).
9005 Dynamo-electric Machines, F. Wynne, Westminster.
9015 Machinery for Manufacturing Paper, G. Mills and G. H. May, Glasgow.
9026 Boats, J. H. Carson, London.
9027 Propulsion of Vehicles, W. Powell, London.
9032 Electric Arc Lamps, W. R. Mortimer and J. Holloway, London.
9038 Grinding Machines, T. Plesner, London.—[Complete Specification.]

June 21st.

9046 Magneto-electric Bells, E. Cox-Walker and A. A. C. Swinton, London.
9049 Aneroid Barometers, F. G. Phillips, London.
9056 Propeller Blades, W. Scotson, Sheffield.
9057 Steam-boiler Furnaces, A. W. Bennis, Manchester.
9060 Valves, J. Thompson and J. T. Hailwood, Rochdale.
9062 Motor Engines Operated by Explosive Mixtures, W. P. Theermann, Manchester.
9063 Lubricators, St. J. V. Day, Glasgow. (J. J. Stever, United States.)—[Complete Specification.]
9066 Actuating the Door Locks of Railway Carriages, J. C. Park, London.
9069 Mariner's Compass, J. C. Dobbie, Glasgow.
9071 Locking and Unlocking Railway Carriage Doors, J. A. Hope, Glasgow.
9088 Piston for Steam Engines, B. Bianchetti, London.—[Complete Specification.]
9090 Horizontal Tubular Boiler, L. White, the younger, and W. Y. Baker, trading as the Thames Bank Iron Company, and C. J. Watts, London.—[Complete Specification.]
9094 Utilising Hydrocarbon Fuels as a Source of Mechanical Power, A. S. Jones, London.

PUBLISHERS' ANNOUNCEMENTS.

BACK NUMBERS of "The Practical Engineer," from the commencement, can be obtained at either of our offices in London or Manchester, or by order of any Newsagent.

Vol. I. (bound), containing Nos. 1 to 44 inclusive, from March to December, 1887, price 6s. 6d., can still be obtained by order from any Newsagent, or will be forwarded, carriage paid, from either of our offices on receipt of the amount by postal order or stamps.

Numerous complaints having been made to us by Subscribers of the difficulty they experience in obtaining copies of the *Practical Engineer* in certain districts, we have to state that the Journal can be obtained by any Newsagent through the ordinary trade channels, and no difficulty should therefore exist in obtaining copies by order of any Newsagent.

For the information of the trade, we may state that copies can be obtained from either of our Offices in London or Manchester, or from any of the following wholesale houses.

W. H. SMITH & SON, Strand, London.
W. H. SMITH & SON, Blackfriars Street, Manchester.
JOHN HEYWOOD, 11, Paternoster Buildings, London, and Deansgate, Manchester.
ABEL HEYWOOD & SON, Oldham Street, Manchester.
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EDITORIAL NOTICES.

All communications for the Editor of this Journal should be addressed to 6, Victoria Station Approach, Manchester.

Communications intended for insertion in the current week's issue should reach us not later than Tuesday Evening.

We cannot undertake to return rejected manuscripts or drawings unless accompanied by a stamped and directed envelope.

Contributors are requested to write on one side only of the paper. Sketches should be sent on separate sheets.

TO ADVERTISERS.

Advertisements intended for insertion in the current issue should reach us on Wednesday morning at the latest.

THE
PRACTICAL ENGINEER.
JULY 6TH, 1888.

DEFECTS IN NEW BOILERS.

THE explosion of a new boiler under normal working conditions within seven months of being set to work is happily an event so rare in this country, that the facts in connection with an explosion which occurred at a cement works at Grays, in Essex, and particulars of which are given in the report of No. 265 Preliminary Inquiry under the Boiler Explosions Act, just issued, are of more than ordinary interest, and call for more than passing notice.

The boiler in question, from which the explosion arose, formed the left-hand one of a group of three, set side by side, and all of similar construction. It was of the Lancashire type, and measured 26ft. in length by 7ft. in diameter, the working pressure being 80lb. on the inch.

The shell of the boiler was of iron ½in. thick, made of Messrs. John Brown and Co's. *single* best plates. It was constructed of seven belts of plating, with three plates in each ring. The longitudinal seams were of the ordinary overlap description, the rivets being ¾in. diameter, and pitched about 2¼in. apart.

The boiler was equipped with the usual complement of fittings, including two lever safety valves, loaded to 83lb. per square inch, two glass water gauges, and a dial pressure gauge, graduated to 100lb. Indeed, as far as could be judged from external appearances the boiler was well appointed, and quite capable of resisting the pressure at which it was worked. Taking the thickness of the plates and pitch of rivets given, and assuming the iron to have had a tenacity of 20 tons to the inch, the shell of the boiler was able to resist a bursting pressure of upwards of 350lb. on the inch, and thus afforded a factor of safety of nearly 4½ by calculation.

The explosion was of a most violent character, the shell of the boiler being ripped to pieces, and the fragments hurled in all directions. The boiler-house was completely wrecked, and the two boilers alongside thrown from their seats. Fortunately, although the destruction of property was very great, the injury to persons was comparatively slight, due no doubt in great measure to the fact that the disaster occurred at nine o'clock in the evening, when there were few persons about. The only person who was seriously injured was the fireman. He was throwing coals on one of the fires at the moment the explosion occurred, and was blown into a sunken roadway about seven feet deep, situated a few yards in front of the boilers.

From an examination of the fragments, there could be little doubt that the rupture of the shell commenced, in the first instance, at the longitudinal seam of rivets at the bottom of the first belt of plating. At this seam there was a flaw in line with the inner row of rivet holes, and extending right across the entire width of the plate. The flaw had evidently existed for a considerable time, but as it was covered with the overlap it was quite concealed from view, so that it would have been quite impossible to have discovered the defect by inspection after the boiler was made. The report states that the flaw was probably started during the construction of the boiler, and in this opinion we quite concur.

The possibility of a new boiler being set to work with such a defect in existence is one calculated to fill the minds of steam users with consternation and alarm, and we therefore propose to make a few remarks regarding the cause of such defects in the first instance, and the means to be adopted to prevent them. The cause of the flaw in the present instance is, we think, rendered pretty clear by the evidence brought out in the report. The plates of the boilers, as we have already stated, were branded "best," and this, in the absence of any further explanation, might by the uninitiated be taken to imply that the brand was as good as could be obtained. Seeing, however, that the plate makers had a better quality marked "best best," and a still higher brand designated as "best best best," it will be evident that the word best, as applied to the plates, had only a relative value, and that it was in fact about the worst quality made, and not at all a desirable material to use in the construction of steam boilers.

The poor quality of the plates employed for the shell appears to have been noticed by the inspector of the boiler insurance company with which the boiler was insured, and Mr. Michael Longridge, the chief engineer, addressed a letter on the subject to Messrs. Whitmore and Binyon, the makers of the boiler, pointing out the low quality of the plates used, to which, however, they replied somewhat curtly that they had "a different opinion of the quality of Brown's 'best' plates" to that expressed by Mr. Longridge.

Turning to the treatment of the plates during the process of construction, we cannot do better than quote the evidence given in the report of the foreman boiler-maker, who stated that "the shell plates were punched before being bent; after being punched the corners of each plate were thinned down where required. They were then rolled while cold, and the required curvature of the end portions of each plate which could not be given in the rolls was effected by placing the plate on one edge, and *bending it by blows from a hammer, one man holding up and another striking.* The plates were then bolted together by tack bolts, and screwed as close as possible. Drifts were occasionally used at the works, but not to a large extent. He could not, however, say drifts were not used in the construction of the boiler under consideration." Questioned as to the liability of the plates fracturing under the process of bending the ends, "he had only known three plates to fracture in the operation during his twenty years' experience, and in one of those cases it fractured between the rivet holes."

The treatment of boiler plates in the manner indicated by italics in the above quotation is savage treatment at best, but when the plate operated on is one of low quality to begin with, and has a line of rivet holes punched across it at the very part where the punishment is inflicted, it is easy to see that unless great care is exercised the process is calculated to distress the material very seriously, and the wonder is that with such material and such treatment defects should not have been more common, and explosions like the one under consideration more frequent. Probably there are more defects of the kind indicated than is generally thought, as it is only when their existence is revealed by a disastrous explosion that public attention is called to them. It will be observed that the foreman admitted to having met with three such defects in his experience. But it should be remembered that it is very easy for a fracture as fine as a hair to escape detection in a workshop, even with the best of intentions and the strongest desire to turn out honest work. Once the plates are riveted together, the defect is, of course, hidden away for ever, unless it ultimately leads to disaster.

The way to avoid such defects is to use only the best of material and the best of workmanship. All the rivet holes should be drilled after the plates are bent, instead of being punched first and then bent afterwards, while the use of the drift to the holes, or the sledge hammer to the ends of the plates in bending, should be rigorously avoided. With the present low price of mild steel, and the beautiful quality of that material now produced, there is less excuse than ever for the use of iron plates, even when of first-class quality, while the cheaper brands of iron plates are to be avoided on every ground. It cannot be too emphatically stated that *ductility* is the quality of all others which is to be desired in any material used in the construction of steam boilers, and it is in respect to this particular quality that the common brands of iron plates are most lacking. For such structures *tenacity* without *ductility* is worthless.

The bending of the ends of the plates is a point in which there is some little divergence of practice in different shops, and with the ordinary arrangement of rolls it would seem almost impossible to secure the curvature of the plate right to its extreme end, unless some special means be adopted, and it has been argued by some that to secure complete and uniform curvature of the plate a certain length at the end of each plate should be cut off; and without going so far as to endorse this view, we think the bending should be effected by gentle means, and that the use of the sledge hammer for this purpose should be avoided. The point is one of considerable practical importance, and we shall be glad to open our columns for the discussion of the matter by those of our readers who are specially interested and experienced.

There are several other points in the report which call for notice, but want of space forbids our dealing with them on the present occasion, and we must defer further reference to another issue.

THE CHANNEL TUNNEL.

UNDETERRED by previous defeats, Sir Edward Watkin, on behalf of the promoters of the Channel Tunnel, entered into another bout with the Legislature and suffered another fall in connection with the subject of establishing railway communication with this country and France. The immediate issue on which the question on this occasion was fought was the second reading of a bill which Sir Edward and his friends desire to pass through Parliament permitting them to make experiments; but they do not conceal their intention, if the experiments succeed, of pressing for powers to make and work the tunnel. It is, of course, idle, in face of this declared intention on their part, for the promoters to urge that the Government of the day could at any time put a stop to it, as the promoters would undoubtedly claim, and reasonably so under such circumstances, that compensation should be awarded them for disturbance. This being the case, it was necessary that the question should be considered with regard to the larger issue involved, and it was really on the question of tunnel or no tunnel that the decision was taken. The result was that the second reading was rejected by a large majority. The division was in no sense a party one, and resulted in some peculiar cross voting. We cannot but think that the judgment of the House expressed the feeling of the country at large with regard to the scheme. That the establishment of such a communication would necessitate the erection of fortifications at the mouth of the tunnel to guard against surprise is admitted. The question therefore arises whether the country should be put to the trouble and expense of additional fortifications for the benefit of private individuals in the shape of a joint-stock company, for that is what the scheme really resolves itself into. The answer is a distinct and decided negative, and we trust it will be accepted as final.

EDISON'S PHONOGRAPH.

A DESCRIPTION of Edison's improvements in the phonograph was published in the papers some little time ago, but the first instrument embodying his latest developments and perfections has only just reached this country. In the first design, it will be remembered, the record of the sounds was made on a sheet of tinfoil wound round the barrel of the telephone by a small indenting stylus, actuated by the vibrating membrane of the mouthpiece of the instrument. In the perfected design the tinfoil coating of the barrel is replaced by a coating of wax, while several other improvements have been effected which render the instrument much more life-like in its reproduction of the original speech. Mr. Gourand, of Upper Norwood, Surrey, who was the recipient of the first instrument, in writing to the *Times* with regard to it and the phonograms forwarded with it, relates some of his experiences in listening to the first utterances of the instrument. The first phonogram which was translated was from Edison himself, and Mr. Gourand states that he had the pleasure of listening to his familiar and unmistakable tones ten days after they were spoken, and after having travelled across the Atlantic, the words being so clear and distinct that not a single one required to be repeated to be understood by every person present, including a child seven years old. Amongst other things, Mr. Edison told him that the instrument was the first that had left his hands or been outside his laboratory. Another phonogram was a poem entitled "The Phonograph's Salutation," by the Rev. Horatio Nelson Powers, which had been spoken by the poet himself into the instrument. The voice of the author (says Mr. Gourand) was at once recognised by the several members of his family, who were familiar with it in consequence of having listened to his preaching in former years. Mr. Edison also sent for amusement a number of musical sounds, including solos and duets of pianoforte, cornet, and other instruments, many of which had been repeated hundreds of times. The capacities of such an instrument are almost boundless, and if its accomplishments are half as great as is reported, shorthand writers and reporters will shortly have to seek other employment.

THE ROYAL COMMISSION ON EDUCATION.

THE Royal Commission on Education, which was appointed over two years ago, has just completed its labours and presented its final report. The report is of a most voluminous character and consists of 2,500 pages, exclusive of three volumes of evidence, already issued. The main portion of the report deals with matters which are foreign to our columns, but, as it touches upon the important question of technical instruction, we offer no apology for quoting from its pages. Referring to this subject, the Commission recommends that drawing should be made a compulsory subject in all boys' schools as far as practicable, and that although boys while at school should not be taught the trade of carpenter, builder, stonemason, fitter, &c., it considers that some elementary instruction in science is second only in importance to reading, writing, and arithmetic, and is in favour of continuing and extending the work of instruction in science. Handicraft instruction, it is urged, should not be introduced until a certain standard is attained, and the manual instruction should be in workshops established for the purpose, to which boys of exceptional ability might be admitted. This method, it is thought, would be better and cheaper than such teaching would be in elementary schools. It is further urged that nothing should be done to discourage existing voluntary effort, or lead the artisan to trust rather to the artificial training of a school than to the practical and diversified training of the workshop. Such technical schools should only be established where the judgment and practical experience of the locality, as evidenced by adequate local contributions for the purpose, have determined that they are necessary, and the central authority should interfere as little as possible with the methods, provided they appear generally sufficient. The control of technical education, it is recommended, should be in the hands of municipal bodies or rating authorities, the immediate direction of such schools being placed in the hands of a body mainly composed of persons interested in the trades of the locality and experienced in its industries. Where sufficient local interest is shown to exist by voluntary contribution or by levy of a rate, a contribution from the Parliamentary grant may, the Commission states, be properly made to reinforce local resources; but technical schools should be made as far as possible self-supporting by fees.

ON TUESDAY last two "steeplejacks," engaged repairing a chimney at Church Lane Colliery, near Barnsley, were killed through the failure of the scaffolding.

LITERATURE.

The Mechanics' Workshop Handy Book. By HASLUCK. Price 2s. London: Crosby Lockwood and Son.

THIS, as its name implies, is a handy book, and contains much useful information with regard to the "why" and "wherefore" of many of the innumerable operations and processes of a mechanics' shop, and the knowledge of which cannot but increase the interest and appreciation of the young mechanic in the work he has to do. A description of the principal metals and their alloys is followed by interesting chapters on the treatment of iron and steel, including forging, welding, tempering, and hardening. A description of the principles which govern the cutting angles of tools, especially with regard to drills and drilling, will render the book specially interesting and valuable to the turner. Altogether the book is one we can honestly recommend to every mechanic who desires to base his knowledge on scientific principles, instead of, as is too often the case, on rules of thumb.

Calvert's Practical Notes on Screw-cutting, with Examples and Formulæ. Price 2s. 6d. London and Manchester: John Heywood.

THIS little book consists largely of exhaustive tables of change wheels for cutting screws of almost every conceivable pitch, both in English and French measure, and will undoubtedly be of great service to those who have much of this class of work to do.

IMPROVED VACUUM.

IN our article on "The Money Value of Vacuum" (*Practical Engineer*, January 20, p. 26), we pointed out that a good engineer, by improving the vacuum only two or three pounds in a pair of moderately-sized engines, which can frequently be done by attention to very simple matters, could easily save for his employers an amount equal to his own wages; and in our subsequent articles on "Bad Vacuum," &c., we pointed out some of the reasons why the vacuum was often not so good as it should be, and indicated some of the steps which should be taken to bring about improvement. Since these articles were written we have received copies of diagrams, which we reproduce below, from one of our readers, who was some time ago appointed head engineer to a large coal and iron works, where there were a number of very large engines, which, for various reasons, were in an extraordinarily neglected state. One of these was a large vertical compound condensing engine, with high-pressure cylinder, 43in. in diameter; low-pressure, 72in. diameter, each having a stroke of 5ft., and running 56 revolutions per minute. The "constant" for the L. P. cylinder of this engine, it will be seen, is an unusually large one, being as much as 78·3, or, in other words, the effect of an improvement of 1lb. in the vacuum in this cylinder would be equivalent to a clear gain of 78·3 indicated horse power (less, of course, the slightly increased resistance put upon the air pump), or more than three times as much as in the engines taken for illustration in our first article, above referred to. In November last this engine was driving from 1,370 to 1,720 I.H.P., and the diagrams from the low-pressure cylinder were as shown in fig. 1, the maximum effect of the vacuum on the large piston being only some 2¾lb. per square inch. The arrangement of air pump and

FIG. 1

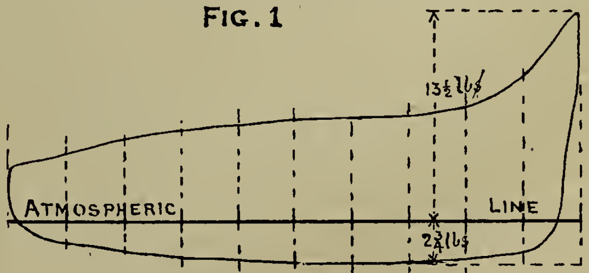

Diagram taken before alterations.

connections being defective, a new air pump and condenser have since been put in, with the result that an improvement has been made of not less than 7½lb. in the vacuum on the average (see fig. 2), which, multiplied by 78·3, gives a gain of 587·25 I.H.P. as the result of this alteration from improvement in the vacuum alone. Deducting from this the extra work done by the air pump (3ft. dia., 3ft. stroke), about 40 I.H.P., we have a clear net gain in this instance of nearly 550 indicated horse power. If we take the fuel consumption as equivalent say to 4lb. of coal per I.H.P. per hour, we have as the money value of this improvement, which is not a fanciful one, $\frac{550 \text{ I.H.P.} \times 4\text{lb.} \times 56 \text{ hours}}{2,240} = 55$ tons of coal per week on an engine running 56 hours per week, such as we took in our previous supposition, and 55 tons of coal at six shillings per ton represents a money gain of something like £16 10s., or about £860 per annum in the working of this large engine alone, certainly an amount which would warrant the incurring of a very considerable outlay in alterations.

FIG. 2

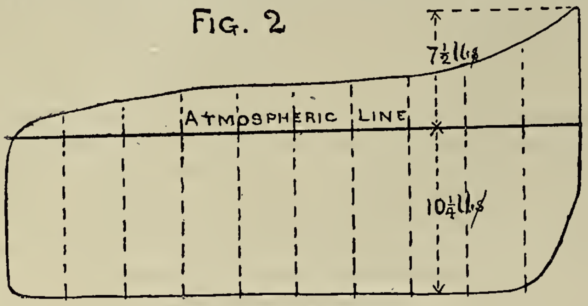

Diagram taken after alterations.

The diagram fig. 2 shows a maximum "vacuum" in the cylinder alterations of 10¼lb. only, but our correspondent writes us that he now frequently gets as much as 12lb., and the actual saving in coal is over 60 tons per week. This, we believe, is not by any means a solitary instance, many large engines, especially in places where coal is plentiful and cheap, being, to our own knowledge, worked at an extravagant expenditure of fuel. It suffices, however, to illustrate how very much depends on having a good and careful engineer, thoroughly acquainted with his work, and capable of watching every point in which improvement may be made.

Much misconception exists amongst practical men as to the effect of cold water in obtaining a good "vacuum," and many engineers believe that the colder the condensing water can be obtained and the better will be the vacuum. The temperature of the water is, of course, an important element in obtaining a good vacuum in the condenser, and where the vacuum is defective this should at once be seen to, but it has only an effect prejudicial or otherwise within certain limits.

Water boiled in a perfect vacuum, for instance, only gives a pressure of about 1¼lb. (equivalent say to a "vacuum" of 13½lb. or 13¾lb.) at a temperature of 110° F., and, as we can never hope in actual practice to get much beyond this, little attention need be paid to the heat of the ejection water when it is not heated up to a temperature beyond 100 or 110° at the point of discharge in the hot well. Indeed, when the feed water for the boilers is taken from the hot well, it would be folly to leave the water at a much less temperature than this, because advantage may be taken of the heat obtained from the exhaust steam, even in a condensing engine, up to this point, without suffering any loss from the impairment of the vacuum. Hence, if an engine is supplied with condensing water at say a temperature of 40° F., and the temperature at discharge is found to be not more than 60°, the supply of injection or condensing water might with great advantage be restricted until the water at discharge reaches a temperature of over 100°, or from 100° to 110°, and a clear gain of over 40° in the heating of the feed water might be thus gained, equivalent to nearly 31,000 foot pounds of work, which would otherwise have to be supplied by an increased consumption of coal. Hence an intelligent man, if he have a good vacuum gauge connected to the condenser of his engine, will regulate the supply of condensing water by this, so adjusting it that he may get the water for feeding the boilers as hot as possible, without in the slightest degree increasing the condenser pressure, or, in other words, impairing the effect of the vacuum or the large piston.

When the indicator diagrams show that considerable loss is being experienced from defective vacuum, the temperature of the water of discharge in the hot well, or ejection water, should, as we have said, be first of all seen to, and if this is high, reaching say 130° or 140°, attention should be at once given to it, and a larger supply of condensing water should be admitted if possible; or if the diagrams show that the steam is being exhausted from the condensing cylinder at too high a pressure, then it will pay much better to give attention in the first place to the reduction of the pressure before exhaust, such as by cutting off earlier, and expanding the steam down to a lower pressure before exhaust, should the load on the engine, initial pressure available, and other conditions, &c., render this practicable. The admission of air, however, in some part of the condensing apparatus, or in the cylinder itself, as we have pointed out in our previous articles, is one of the most frequent causes of defective vacuum, and it was at one time not an uncommon practice for a maliciously-disposed engineman, when discharged, to make a small hole in the low-pressure exhaust pipe or the injection pipes, or some other connection to the condenser, where it would be difficult to discover; so that in this way air would be drawn in to destroy the vacuum, and render working by condensation difficult or almost impossible until the defective place was discovered.

LOCOMOTIVE PRACTICE.

In an article on the divergent practice of locomotive engineers, our contemporary, *Engineering*, gives some interesting information based on a report by Mr. C. Rous Marten to the Minister of Public Works in New Zealand. Mr. Marten spent several months studying our railways, and his report deals very exhaustively with the peculiarities of the engines on various lines, as well as with the divergent practice of the different engineers.

Referring to the boilers of the engines for working the fast trains, he found the heating surface varied from 1,000 to 1,500 square feet, the following being the areas adopted in the principal express engines: Great Western, 1,278 square feet; London and South-Western, 1,216 square feet; London, Brighton, and South Coast, 1,284 and 1,485 square feet; Great Eastern, 1,200 square feet; Great Northern, 1,021 and 1,165 square feet; London and North-Western, 1,074 and 1,450 square feet; Midland, 1,121 and 1,313 square feet; Manchester, Sheffield, and Lincolnshire, 1,144 square feet; North-Eastern, 1,208 square feet; and Caledonian, 1,208 square feet.

He found the greatest diversity of opinion to exist with regard to the bogie question, the Great Western, London and North-Western, and London, Brighton, and South Coast rejecting it altogether, even for the tank engines; the London and North-Western substituting radial axle-boxes. The Great Northern uses the bogie for only one class of express engines, but employs it freely on tank engines. The Great Eastern has a large number of bogie locomotives running, both tank and main line engines, but is dispensing with bogies on new express engines, save on the compounds. The Midland uses it for all tank engines. but of the new express engines there are more without it than with it. The London and South-Western uses it on all new passenger engines. So does the South-Eastern and the London, Chatham, and Dover. The Manchester, Sheffield, and Lincolnshire Railway uses it with the coupled engines, but not with the singles, thus reversing the Great Northern practice.

Mr. Marten also gives some interesting information with regard to the speed attained on the various lines. He records that on three occasions only, all of a somewhat special character, did he register a speed of 76·28 miles an hour, with light loads, down gradients of 1 in 89 to 1 in 200; once with a Great Western 8ft. single, once with a Great Northern 8ft. single, and once with a Midland 7ft. coupled. In each case the engine was pressed to its utmost capacity. The highest speed ever known to have been attained in this country is recorded of the ten-wheeled tank engines, with 9ft. single driving wheels, built for the Bristol and Exeter line in 1852, which actually touched 80 miles an hour, with no load, down a gradient of 1 in 89, and 78 miles with vehicles.

One of these engines ran 70 miles an hour on the level, with ten coaches. From this, it will be seen that the ordinary heavy express is strained to its utmost limits, and has frequently to make 70 to 75 miles an hour down hill to keep time. Mr. Martin records that, with the Great Northern express, between London and Grantham, he twice covered 100 miles in 103 minutes, and on the Great Western, between London and Swindon, 72 miles in 71 minutes, the engine in each case being an 8ft. single driver.

The highest average speed at which a train is timed from start to stop is just 54 miles an hour. This is the Great Northern Manchester up express, which performs the longest run in the world without a stop—105 miles 26 chains, to be done in one hour 57 minutes. The Great Western Exeter expresses stand third with 53¼ miles an hour.

AN ENGINEER'S LIFE AT SEA.—IX.

BY A SEA-GOING ENGINEER.

[*Continued from page 281.*]

LEAKS, &c.

As soon as steam leaves the surface of the water in the boiler its losses begin. The boiler shell, and afterwards the engines, rob it of heat, which is radiated away into space. Of that which disappears in mechanical power, part is transformed into the heat of friction in the engines, or in the violently agitated water about the propeller or at the bows of the vessel. A part of the steam is lost by direct leakage, and it is with this the engineer has to deal. When a steam joint leaks it is stopped by a temporary wooden wedge. This is often the only method available, but after a watch or two the leak will probably begin again by the side of the wedge, and a new one will have to be inserted beside it, till by the time the vessel reaches port the joint is bristling all round with wooden wedges, put in to follow the leak. Sometimes one will blow out with a report like a pistol shot, startling inexperienced engineers on solitary watches.

Besides leakage at joints, there is also leakage at glands to contend with. If the pistons have tail rods, the gland on the high-pressure one will probably be found the most troublesome. These rods are never in mathematical line with the piston rods, and by working about in their stuffing boxes destroy the packing, and thus leak. "Coreless" or "metallic" packing, being the least yielding, usually keeps the tightest, but the packing must always be carefully seen to. In many engines these rods are dispensed with as of more theoretical than practical use. They are not needed as guides, and are also too light for this purpose, while as balance rods, much if not all their benefit can be attained by proper proportion of ports and setting of valves.

Piston-rod glands are frequently tightened without stopping the engines; but as this is often a risky operation, it should never be attempted by the tyro until confidence is gained. Sometimes the rash are taught caution by having their hand-lamp crushed by the crosshead, or knocked into the crank pit. Practice, however, brings coolness, and lessens the risk. Care must be taken to tighten the gland equally all round by keeping it parallel with the cylinder bottom, or by seeing that it is equally open all round the rod; then the nuts must be carefully locked. This cannot be properly done against the yielding gland, especially as, with four studs, the chief strain can only be on three at a time. When lock-nuts cannot be got on, and there is no hole for a split pin, at least a bit of string can be tied round the stud below the nut. This, though not the most mechanical method conceivable, will be found effective in keeping on the nuts. When a high-pressure piston gland is tightened more than is actually necessary, its friction, added to the high temperature of the rod, will sometimes lead to the formation of deep groovings in the rod, which have to be smoothed over at intervals with the file. With a rod thus grooved the gland has to be kept tightly screwed up to prevent excessive leakage, and this again tends to aggravate the groovings. A valve spindle gland is more easily kept tight, but this also must not be tighter than necessary, or the brasses will rattle and wear unduly.

Any hidden leaks of either valve or piston will be shown on the indicator diagrams, but care in overhauling will prevent this. A leaky valve will show marks on the bridges when the valve is removed. In port the tightness of a piston is easily determined by removing the junk-ring, and in a low-pressure cylinder the looseness of its piston will sometimes be known by the appearance of the cylinder surface, or by the presence of grease balls. These balls will be plentiful if common oil has for any cause been used to lubricate the cylinder, and as these cannot well be got at on the under side of the piston, they are injurious by diminishing clearance. In taking up wear of springs, a careful "second" will note when the opening in the circular spring is getting too wide for the tongue-piece, so that another of these may be ordered and ready for insertion at the end of the next voyage.

When high or low pressure diagrams are compared, a "gap" will be found between them. This is due to a loss of pressure by cooling in the intermediate receiver. Some regard it as loss by expansion in the receiver, but if so, the high-pressure exhaust would show the same pressure, and there would be no loss. The steam has to remain in this chamber for at least a quarter of a revolution, and this is long enough to produce partial cooling. Thus the loss of pressure shown is due to contraction by cooling, and not to expansion. Of course the expansion in the low-pressure cylinder has nothing to do with the "gap." Besides this loss, there is little probability of direct leakage into or out of the receiver, as it is nearly at the same pressure as the surrounding atmosphere.

As soon as the steam in the low-pressure cylinder falls below atmospheric pressure the leaks become invisible, as they are *into* the engine and not out of it, as before, the escape of steam giving place to an indraught of air. Sometimes this sucking in of air may be heard, and at other times detected by the flame of a lamp applied to the suspected place. As this cannot well be done with glands, it is best to tighten up the gland a little, and watch the vacuum gauge. Should the tightening have an appreciable effect on the vacuum, further tightening will only increase friction. If a cool condenser but a lower vacuum than usual causes a leak to be suspected, a light tap on the plug of the drain pipe will insure its tightness, for in some cases the end of the drain pipe is open to the crank pit and not to the condenser. The tail rod gland may be tightened up with an eye to the gauge, as before. A light must be passed round every accessible joint on cylinder or condenser. If the leak should be about the air-pump valves, it will soon get worse and necessitate stoppage. The defect may, however, be in the gauge itself, though an experienced ear can tell by the sound of the engines whether the loss of vacuum is apparent or real. A temporary shutting off of the gauge will show how it holds its vacuum, and decide if there is a leak there or not.

But water as well as air tries to force its way into the vacuum of the condenser. Such leaks are sometimes caused by the condenser getting overheated in starting, or more frequently during an enforced and perhaps sudden stoppage at sea. Such a leak will tend to improve the vacuum, but it overloads the air pump, which may be thus made to give out, and also by putting cold feed continually into the boilers steam suffers, and consumption of coal increases. Where the leak is such that the frequent blowing down has to be carried on to keep the water at its proper level, it is time to stop and plug the leaky tubes at each end. As the leak will be found only to come from one end of the tubes, getting the position of each by counting, as well as by shining a lamp at each end, is necessary to ensure the right ones being plugged.

The feed should enter the boiler at a temperature of about 130°, which is about as hot as can be felt by the hand. This is, of course, much higher than where a jet condenser is used, and it is one of the advantages of surface condensation. The feed water also passes along its pipes into the boiler fresh as well as hot. There it joins the circulating water in the boiler, and again leaves it as steam, at a high pressure, to pass into the cylinders, there to be cut off and expanded, then exhausted into the condenser, and in the form of water put back into the boiler again. In this circuit, the cut-off in the high-pressure cylinder is such that the pressure of the steam just before exhausting is sufficient to overcome the friction of the engine itself, so that the high-pressure piston may not be a drag on the low-pressure one. In the low-pressure cylinder, if the steam were admitted for more than half the stroke, it would get a second charge of steam from the exhaust of the high-pressure cylinder. The young engineer must in this way trace the steam round and round in its circuit, till he knows well every part of its course, and understands all the preventable sources of loss in the engines.

A NEW PROCESS FOR INSULATING ELECTRIC WIRES.

According to the *Indian Paper Journal*, a new process for insulating electric wires has recently been patented. This invention has for its object, first, the insulation of electric leads, notwithstanding dampness, and, on the other hand, to draw closer the two leads in a single strip, in such a way that their relative positions could not change, excluding by these means the possibility of short circuits, &c. The patentees proceed as follows: Two or more copper wires, according to the current to be transmitted, are placed parallel, at a suitable distance, and covered with several layers of paper strips, which have previously passed into a bath of ammonia oxide of copper. The paper band bears now on its surface a coating of cellulose. Then, by forcing the whole through a suitable pair of rollers, the cellulose of one spiral unites with the cellulose of the next, and forms an even compact mass. When passing through the rollers, the copper wires are so carefully guided as not to be displaced or brought in contact. The strip passes again into the copper bath (which disintegrates the cellulose to a certain depth), and then goes to a pair of rollers heated by steam under a very high pressure; the lead comes out dry and smooth. When still warm it passes into a bath of boiling linseed oil, which penetrates into the paper layer. After going once more through the rollers, which throw out the excess of oil, the strip comes out perfect. It is then quite flexible and elastic, and dampness cannot reach the wire.

SETTING FOR LANCASHIRE BOILER, 7ft. 6in. Diameter.

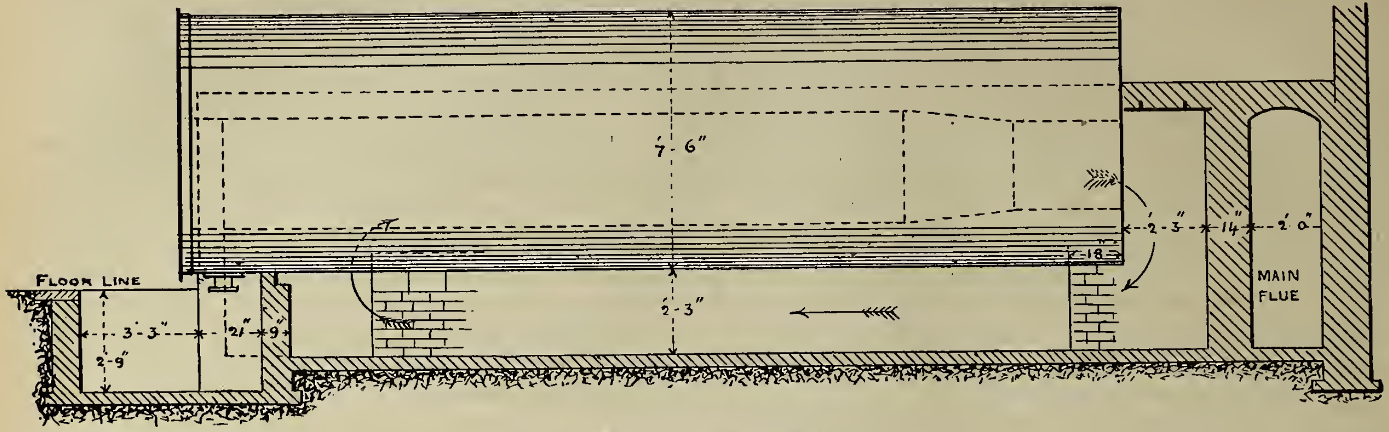

Fig. 1.—Longitudinal Section.

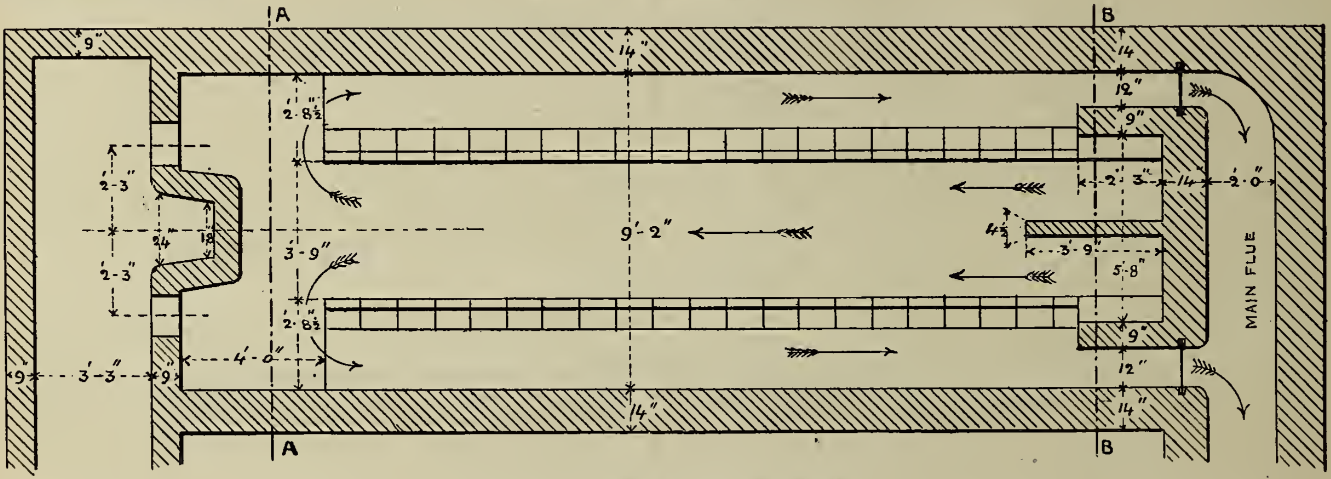

Fig. 2.—Plan of Seating with Boiler Removed.

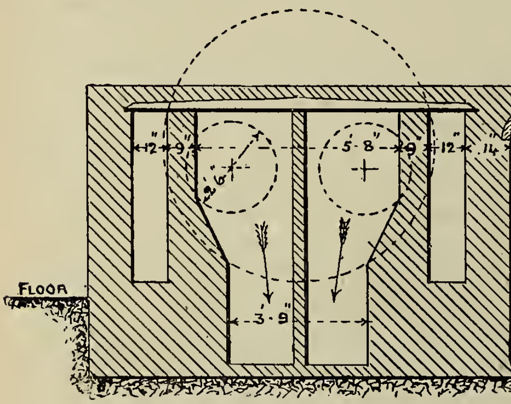

Fig. 3.—Section through Downtake at BB.

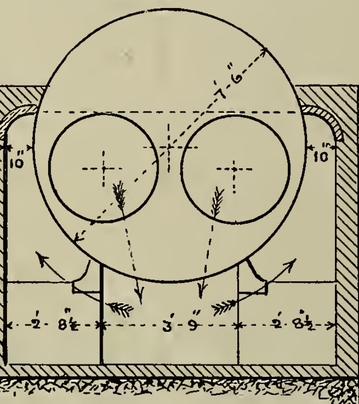

Fig. 4.—Section through Uptake at AA.

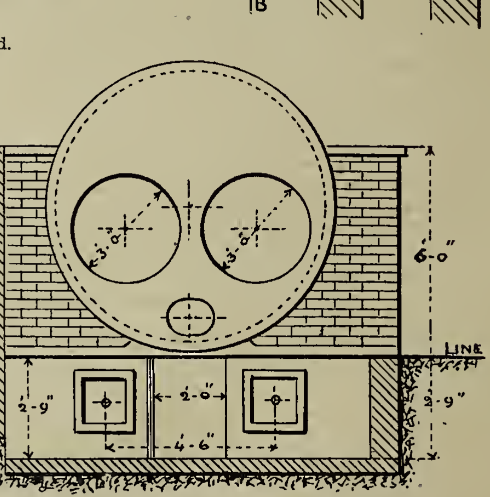

Fig. 5.—Front View, with Section through Hearthpit.

The setting of boilers, although apparently a simple matter, is frequently executed in such a way, judging from the numerous instances that have come under our notice, as to cause us to doubt whether those who are often responsible for carrying out such work either understand the points that should be aimed at, or the principles that should govern the construction. It would be no exaggeration to say that defective setting is responsible, directly or indirectly, for more disastrous boiler explosions than probably anything else.

Not unfrequently the flues are so constructed as to render it utterly impossible for a man to pass through them for the purpose of cleaning or inspection, and the boiler is embedded in a mass of brickwork, which serves little or no other purpose than to afford a lodgment for moisture, and to hide from view the wasting by corrosion to which such moisture sooner or later gives rise. To make a thorough examination of such a boiler is very often impossible without taking down nearly the whole of the brickwork setting, and as this is a proceeding involving considerable expense, boiler owners are loth to resort to it, the result being that where inspection is most required and loudest called for, it is, as a rule, the least seldom obtained.

The brickwork setting of a steam boiler has three main functions to fulfil: the first is to increase the heating surface, and thereby reduce the temperature of the gases to the lowest point consistent with efficiency; secondly, to afford sufficient area for the stream of gases, so as to prevent the draught from being impeded; while, thirdly, the flues should be so constructed as to hide as little of the surface of the plates from view as possible, avoid the lodgment of moisture in the brickwork in contact with the plates, and at the same time afford convenient access for the purpose of inspection, cleaning, or repair.

We give drawings above showing the plan of setting a Lancashire boiler 7ft. 6in. in diameter in accordance with the most recent and best practice. Fig. 1 gives a longitudinal section. Fig. 2 shows the plan of the setting, with the boiler removed. Fig. 3 is the section of the down-tube at the *bulk* end, where the gases pass from the internal flue tubes into the brickwork flue running under the bottom of the boiler. Fig. 4 is a section through the uptake at the front end, where the stream of hot gases divides into two portions and enters the flues running along each side of the boiler, from whence they pass into the main flue, and thence to the chimney. Fig. 5 is a front elevation giving the section through the hearthpit beneath the flooring plates. We have selected the Lancashire boiler for the purpose of illustration because it is probably the type most commonly met with in this country for land purposes, while the diameter of 7ft. 6in. is one that is frequently adopted. Occasionally the boiler is set so that the hot gases split into two portions at the back end, instead of at the front as in the plan we have shown. The method, however, is not a good one, and we have known its adoption give rise to trouble from leakage in more than one case, in consequence of the water at the bottom of the boiler remaining stagnant and comparatively cold. By first passing the hot gases under the bottom, and then along the sides, as indicated by the arrows in the plan, this difficulty is to a great extent obviated.

For the purpose of preventing the lodgment of moisture, the boiler should be set on fireclay blocks, as shown in fig. 4. These are specially made for the purpose, and afford a bearing surface about 4in. wide, and by making the floor of the side flues level with the bottom of the boiler, the point of contact of the blocks is raised above it, and thus the risk of corrosion through the lodgment of moisture is reduced to a minimum. It should be stated that the seating blocks are made so that the angle of the bearing surface with the horizontal is constant, and equals 30°. By making the width of the bottom flue, therefore, equal to the radius of the boiler, an even pressure on the bearing surface is always secured.

For jointing the seating blocks where they come in contact with the plates, fireclay, and not mortar, should be used. This is a rule that applies throughout wherever brickwork comes in contact with the plates. The use of lime mortar is always to be avoided, on account of the readiness with which it absorbs moisture, and the danger thereby incurred of setting up corrosion.

It will be observed that the crown of the side flues is covered in with quarter-circle tiles. Like the setting of the seating blocks, these should be of fireclay, and specially made for the purpose. The downtake is shown to be covered in with a cast-iron plate, which extends right across the diameter of the boiler, and also spans the side flues. (See figs. 1 and 3.) Large quarter-circle tiles are sometimes used instead of these plates, but in consequence of their large size, and of their being exposed to the hot gases just issuing from the flue tubes, they are apt to fracture after being at work some time, and allow the crown of the downtake to fall in, so that the flat cast-iron plate, although more expensive in the first instance, is to be preferred as being less troublesome and more satisfactory in the long run.

In some cases that have come under our notice, the corner of the downtake at the bottom has been rounded off with brickwork, with a view to promote the more easy flow of the gases, and the corner of the bottom flue, where it joins the uptake, has also been filled up with brickwork, for the same purpose. We may say, therefore, in reference to those filling-in on corner pieces, that they are awkward to construct, and quite unnecessary. Plans for the bricklayer, if they are to be carried out in practice, should be made as plain and straightforward as possible, and fancy curves, battering, and filling-in pieces, as far as possible dispensed with. In the plans it will be noticed this course has been followed, and that raking or battering is entirely avoided' except at the downtake, where the width diminishes from 5ft. 8in' to 3ft. 9in. (See fig. 3.) The width of the side flues at this part is increased from 10in. to 12in. This is done so as to give adequate area for the damper, and at the same time allow a man to readily pass through. It will be noticed that the openings of the flue tubes are slightly trespassed upon, but this is of no practical importance.

On reference to fig. 2, it will be seen that a short 4½in. partition wall divides the downtake into two compartments, and as this is sometimes omitted, and its purpose is not generally known, it may be explained that its object is to prevent the baffling of the draught where the gas from the two internal flue tubes unite, and which, in the absence of the partition wall, occasionally causes annoyance.

A recess should be formed for the blow-out pipe at the bottom of the boiler, so that it may be quite clear of brickwork, and open to inspection. This is a point of considerable importance, though we are sorry to say it is not always attended to. In some cases the blow-out pipe is bedded in the wall, and several serious failures have occurred in consequence of the pipe being rigidly bound in this way. The upper course of brickwork forming the recess may be reduced to 4½in. in thickness, as shown in elevation, fig. 1, so as to reduce the area of brickwork in contact with the plates.

Although a small matter, it may be mentioned that the brickwork flues should have a 4½in. firebrick lining throughout their entire course.

In order that sufficient room may be afforded for the blow-out and feed pipes with their connecting bends, so as to allow for expansion, the hearthpit should have a width of not less than 3ft. 3in., as shown; also the boiler should be set so as to afford a clear space of 1in. to 2in. between the shell angle ring and the floor plates at the front end; while the shell angle ring should itself project about an inch beyond the front cross wall, so as to be quite clear of the brickwork and open to inspection. We mention these little points in detail, as they frequently get overlooked when the boiler is being set, and sometimes give rise to considerable inconvenience and annoyance afterwards, when it is too late to rectify the mistake.

In the plan shown it is assumed that there is only a single boiler, and the main flue is shown 2ft. wide. If there are a number of boilers in the range, the dimensions of the main flue to the chimney should be such as to afford a sectional area of not less than 5 square feet for each boiler in the range. It is not desirable, however, to reduce the width to less than 2ft., on account of the difficulty of cleaning, &c.

It occasionally happens that the space at disposal is so restricted that the width of side flues, downtake, &c., as well as thickness of walls, shown in the drawings, could not be adopted; and without laying down a hard and fast rule with regard to these dimensions, we may say it is desirable they should, when circumstances will permit, be as far as possible adhered to.

IMPROVEMENT IN PROPELLER BLADES.

At the last meeting of the Institution of Naval Architects the question as to what was the best material to use for propeller blades was discussed at considerable length in connection with the paper by Mr. Wallace, which placed before the members some interesting data with regard to the cost and durability of the materials now in use, or likely to be used for the purpose. His conclusions with regard to the cost per ton were: Cast iron, £24; steel, £38; Delta metal, £115; gun-metal, £130; manganese bronze, £135; aluminium bronze, £145; and phosphor bronze, £170.

In the course of the discussion Mr. Hall, of the firm of Wm. Jessop and Sons, Sheffield, alluding to the fact that the corrosion or pitting which took place in propellers always occurred at the back of the blade, expressed the opinion that as all the corrosion, or rather pitting, took place at one particular part on the idle side of the blades, it was occasioned by the sucking tendency caused by the blades always working in the same direction, and thus in time drawing out of the steel the particles or molecules which had not sufficient affinity in themselves to hold together as corrosion went on. He considered this to be entirely due to the use of so-called mild or soft steel. He had always thought it a mistake to make steel blades too soft. If he were asked his opinion as to the best material for propeller blades, he should advocate the use of a steel of very high tensile strain, say from 70 to 75 tons per square inch, with an elongation of from 7 to 10 per cent in ten inches, and capable of bending to an angle of 50 degrees. Such a steel could now be produced, and, if required, he was prepared to make it.

Mr. B. Martell (Chief Surveyor of Lloyd's Register) agreed with Mr. Hall that steel blades had been made of too soft a material, and said that if Mr. Hall's, or any other firm, could give them a strong steel propeller blade that would not corrode, there was an enormous fortune within the grasp of that firm.

The discussion excited much interest in steel circles, and several manufacturers set to making experiments—among others Mr. John Willis, of the firm of John Willis and Co., "Speciality" Steelworks, Sheffield, the name of the works, by the way, being obtained from a special self-hardening quality of tool steel, of which Mr. Willis is the inventor and sole manufacturer. Mr. Willis now claims to have invented a new method of preserving iron and steel propellers, &c., from corrosion. As already indicated, corrosion very quickly sets in upon the back of propeller blades, and to a much greater degree in steel than in cast iron. The first cost of manganese bronze or gun-metal blades will always be a serious consideration with shipowners, and therefore the improvement of iron and steel blades is of the first importance. Mr. Willis's invention consists in a coating of copper united to the casting, this being effected by the copper plate, properly bent to shape, being placed in and forming part of the mould, into which the iron or steel is then poured, with the result that the copper is firmly united by fusion to the iron or steel face. We have examined a specimen of steel and copper united together in this manner which has been forwarded to us, and the joint appears to be perfect, the steel and copper being fused together and firmly united, and the whole surface of the blade can be covered if desired. We understand that several blades with the backs protected by a copper coating in accordance with Mr. Willis's patent are in process of manufacture in Sheffield. At an early date we expect to be able to give further particulars with regard to the process when it is more fully developed, and the blades fitted and in actual work.

FLAMELESS EXPLOSIVES.

The advantage of a compound which will explode without igniting the fiery gases of a coal mine are so great and manifest, that numerous attempts, with more or less success, have been made by chemists and others to devise an explosive which shall meet the want; and several explosives are now in the market each of which claims some special features over the compounds that have hitherto been used for blasting purposes.

Amongst these compounds is one known as "Flameless Sécurité," which consists of a nitrated hydrocarbon, in combination with certain oxidising agents. By the addition of a certain proportion of an organic salt, the compound is rendered flameless. A number of interesting experiments and tests have been made with the compound, with a view to ascertain how far it fulfilled the advantages claimed for it by the inventors. Two series of independent tests have been made, and they demonstrate beyond all question that flameless sécurité when fired in a mixture of inflammable gases will not cause them to explode. The first series was carried out in May last by Mr. Perry F. Nursey, C.E., who was nominated by an independent authority to supervise the experiments. The second series was conducted by Mr. C. E. Rhodes, the manager of the Aldwarke Collieries, Rotherham. Mr. Nursey's and Mr. Rhodes' tests were carried out quite independently of each other, the one set near London and the other at Rotherham, and both gentlemen have now reported the results. In the experiments made under Mr. Nursey's supervision the flameless sécurité was exploded by electricity in a wrought-iron cylinder containing a mixture of coal gas and air, so proportioned as to produce the most dangerously explosive mixture. Sixteen experiments were made with flameless sécurité and other explosives in order to obtain comparative results. In no one case did the flameless sécurité communicate ignition to the gaseous mixture in which it was exploded. In the case of a cartridge of dynamite, which was rendered flameless by the addition of some of the organic salt, no explosion occurred when the dynamite was fired in it. In some cases the cartridge of flameless sécurité was surrounded by coal dust, and in all cases the cartridge top was open to the gaseous mixture, which made the test most crucial, but in no instance did the ignition of the gas occur. Mr. Rhodes' tests have been carried out during the present month, and he used the apparatus with which he has conducted so many safety lamp tests. It consists of an iron cylinder, with an arrangement for causing a highly-explosive mixture of coal gas and air to travel through it at a velocity of about 6ft. per second, thus approximating the conditions more closely to those of actual colliery working than in the previous case. There was also an arrangement for causing coal dust to travel through the cylinder with the gaseous mixture. Mr. Rhodes carried out a large number of tests with flameless sécurité and other explosives under varying conditions. The results, however, as regards flameless sécurité were the same as those of the previous experiments, which they fully confirmed. Both gentlemen record their independent opinion that flameless sécurité is a most valuable and safe blasting agent, and if properly used will give an assurance of practically absolute safety in mining work, so far as the communication of flame to the surrounding atmosphere is concerned.

Explosions in Coal Mines.—So far as reported, it appears that during the first half of 1888, 38 lives were lost in collieries, owing to explosions, against 122 for the same period of 1887. From the evidence given before the coroners, it would appear that the explosions, almost without exception, were preventable.

HOT-AIR ENGINES.—IV.

(Continued from page 234.)

The internal combustion engine, or that class of hot-air motor in which some of the air passes over and some through the fire, was originally invented by Sir G. Cayley, in 1837. The general arrangement of this engine was so similar to the "Buckett," that the description of the latter will give a sufficiently good idea of the former and earlier one.

The hot-air engine invented by J. Buckett in 1882, and named after him, is shown in section in fig. 6. A is the fire, fed intermittently, as required, from the hopper, B. The valve, R, at the bottom of the hopper closes connection with the heater while fresh fuel is being charged through the door, T. The motive air of the engine, including that required to support the combustion of the fuel, is supplied by the pump, J, which compresses and forces A through the pipe, H. On arriving at the governor valve, G, this air is divided into two parts, one part going through the port, F, around the outside of the fire-brick cylinder, forming the furnace to the chamber, C, under the fire bars, and so up through the fire; the other portion passes through the governor valve and the port, E, to the space above the furnace. The air passing over the furnace is heated by that passing through the fire, and also admits of the more complete combustion of the fuel, the fresh oxygen in the air converting the carbonic oxide, produced by imperfect combustion, into carbonic acid, this giving off more heat. The governor acting on the valve, G, causes more or less air to be passed through the fire, thus regulating the speed of the engine by the rapidity of the combustion of the fuel, and, consequently, the heat and expansion of the motive air. N is the working cylinder, with an inlet valve, P, and an outlet valve, O. The pump piston, K, and motor piston, M, are coupled directly together, so that the strains passing through the connecting rod shall be as small as possible.

Figs. 7 and 8 show a relative set of pump and motor diagrams, taken from a 12 H.P. double-cylinder engine. The air was drawn into the pump at atmospheric pressure and a temperature of about 100° F. It was there compressed to about 28lb. per square inch, and delivered at that pressure to the heater, where it was expanded to about twice the volume. It then entered the motor cylinders at about the same pressure, but with a temperature of about 1,400° F., and was expanded to atmospheric pressure, being finally discharged at the outlet valve at a temperature of 900° F.

The following are the leading particulars with regard to the engines :—

Diameter of cylinder	24in.
Do. pump	18in.
Length of stroke	18in.
Revolutions per minute	61.
Mean pressure in cylinder	18·5lb.
Do. pump	16·8lb.
I.H.P. of cylinder	41·2.
Do. pump	21·0.
Do. effective	20·2.
Brake horse power	14·4.
Consumption of coke per I.H.P.	1·8lb.
Do. do. per B.H.P.	2·5lb.

The coke was fed to the heater in charges of 11lb. to 12lb. at a time, at intervals of about 20 minutes.

The great disadvantages in this class of hot-air engine are :—

1. The heating up of the inlet valve to a red heat.
2. The dust from the fire being carried into the valve seats and into the cylinder.
3. The large proportion (about half) of the gross power being absorbed by the pumps.
4. The high temperature at which the motive air is discharged.

The excessive wear is due to 1 and 2. The large bulk of the engine for the power developed is chargeable principally to 3, and the low efficiency is ascribed to 4; for the fall in temperature between the highest and lowest working limits is only 500°, or,

$$\frac{500}{1,400 + 461} = 27 \text{ per cent,}$$

against a fall of 1,300° to the original temperature of 100°, or,

$$\frac{1,300}{1,400 + 461} = 70 \text{ per cent.}$$

The Stirling engine, described on page 63, when working between the limits of 650° F. and 150° F., gave an efficiency of

$$\frac{500}{650 + 461} = 45 \text{ per cent.}$$

The problem to be solved appears to be, then, how to combine the Stirling cycle with the internal furnace, heating so as to have the efficiency of the former with the direct and more efficient heating of the latter, and also to obviate the destruction of externally fired heaters. Of course, being under the necessity of using a regenerator, a smokeless and dustless fuel must be used, and to be able to carry on combustion sufficient air must be supplied for that purpose, and a certain quantity of the products of combustion withdrawn.

The late Professor Jenkin, assisted by Jameson, carried out several experiments to try and satisfy the conditions just previously mentioned. They constructed an engine, having a heater lined with fire brick, in which a gaseous fuel was burned, the ignition of the gas being effected by occlusion in certain materials; that is, the physical fact, known also as contact action, or catalysis, that the non-explosive and almost flameless combustion of the oxygen of the air and combustible gas is considerably accelerated by contact with the surface or enclosure in the pores of platinum, palladium, iridium, cobalt, nickel, charcoal, pumice stone, porcelain, pipe clay, adamas, chalk, stucco, flour spar, &c. They used cylinders of platinum mixed with pieces of pipe clay, fire clay, or asbestos. The porosity of the internal lining of fire-brick in this class of engine, however, introduced a troublesome increase in the amount of clearance, which it was sought to obviate by vitrifaction of the bricks. But after reducing the porosity by this means from 58 to 30 per cent in the crude brick to 15 per cent in the vitrified one, they came to the conclusion that small engines could not be satisfactorily arranged this way. Apart from this consideration, the unavoidable complication of the complete engine pointed to the same deduction, for it consisted of two heaters, a double-acting working cylinder, two double-acting tandem cylinders, with three valves at each end, to act as pumps for introducing the fresh air required for combustion, and the useful expansion of the corresponding products withdrawn, two air-displacing cylinders, and a cold feed air reservoir.

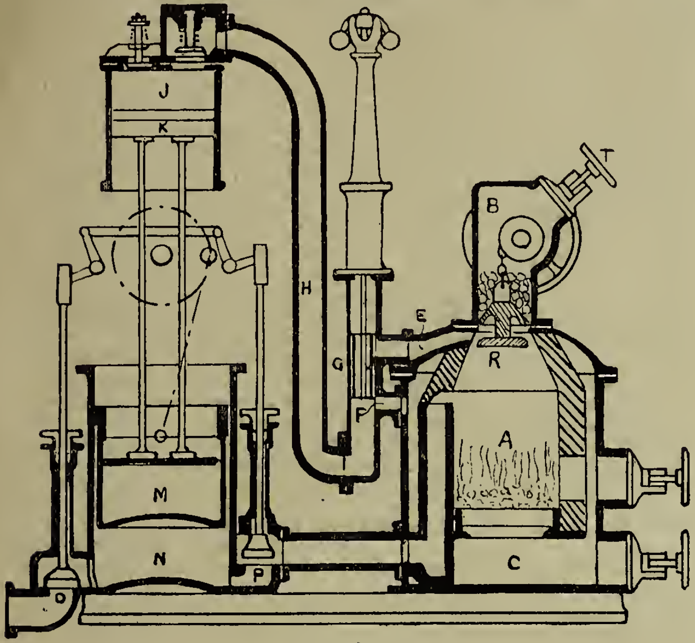

FIG. 6.
The Buckett Hot-air Engine.

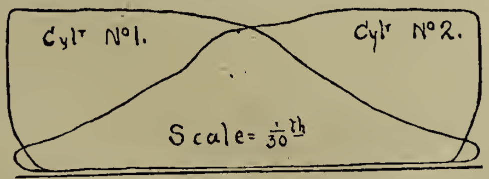

FIG. 7.

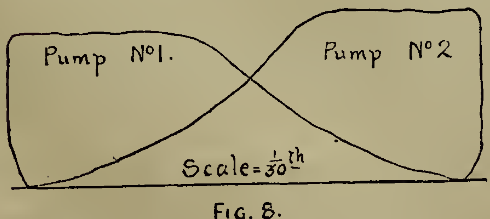

FIG. 8.

Judging from the patent specifications of this engine, the parts do not appear more numerous or complicated than an ordinary compound condensing engine and boilers; and as there is every prospect of a much lower consumption of fuel in the air engine, there is no reason why the construction of a large engine of this type should not be a good speculation.

The Hargreaves motor, lately brought before the public, is certainly another good attempt towards a mechanically perfect hot-air engine. But in adopting the Buckett cycle the efficiency must be lower than if the Stirling cycle were used, although the exhaust is made to heat up the incoming air. The use of a liquid fuel, too, appears to foreshadow further difficulties, caused by the hard charred products of combustion getting between the valve faces. The results of the working of this motor, however, have been so good that the alteration of the cycle might fairly be left out of consideration; and, as regards the liquid fuel, there is every possibility that a little experience will soon suggest some way of obviating any resultant evils.

The general conclusion arrived at must be, therefore, that the possible maximum efficiency and mechanical perfection of the hot-air engine have not yet been reached, and that the direction in which experiments must proceed is pointed out in Jenkin and Jameson's conclusions.

MATERIALS OF ENGINEERING.—II.

Cast Iron.

This, so far from being pure metal, actually owes its value as a material of construction to the presence of foreign matters, the chief of which is carbon. On the relative proportions of carbon present and the manner of its chemical combination mainly depend the strength, fluidity, and adaptability of the metal for its specific uses.

Cast iron is highly crystalline, yet owing to the difference which exists in the proportions and the manner of combination of the foreign ingredients present therewith, its extreme varieties might be almost considered as possessing the qualities of two distinct metals; grey cast iron on the one hand being soft, open grained, easily fractured, and very fluid when melted; while white iron, on the other hand, is extremely hard, close grained, and strong, though brittle, and is pasty when in the molten condition.

Though the difference between the two classes is mainly due to the element carbon, and is partly dependent on its percentage but mainly on its mode of union, manganese, sulphur, phosphorus, silicon, and sometimes arsenic, titanium, chromium, also mingle with iron, and influence its properties beneficially or the reverse. Hence before we can properly estimate the strength and qualities of various irons, we must regard them from the point of view of the chemist, and note the influence of the foreign elements thereon.

The essential object in smelting the ores of iron is the separation from the metal of the oxygen gas which, in the form of various oxides, is naturally associated with all such ores. Something therefore has to be introduced into the blast furnace whose affinity for the oxygen will be greater than that exercised by the iron. Now, oxygen has a greater affinity for carbonic oxide—CO at a red heat than it has for iron, converting it into the higher oxide, CO_2. Hence, if there is introduced and heated to redness in the presence of air a substance rich in carbon, carbonic oxide will be produced, and this will attract the oxygen from the iron, leaving the latter *reduced* to the metallic condition. Carbon, then, in the form of coke or coal, is the *reducing agent*, and this, when raised to a white heat, performs the additional work of rendering the reduced iron fluid.

The infusible matrix or "gangue" of the ore, consisting of silica, alumina, magnesia, &c., is reduced by the flux introduced into the furnace, but at the high temperature necessary for reduction small percentages of these elements become mingled with the iron.

In brief, then, the product of the blast furnace is an impure iron contaminated with silicon, sulphur, phosphorus, manganese, and carbon. It is impossible to obtain iron in the blast furnace free from some or from all of these impurities, because at the very high temperature required for the complete reduction and melting of the metal chemical union must take place. It is possible to control within certain limits the relative proportions of the elements by a judicious selection of fuels, fluxes, and ores, and by a proper management of the blast furnace; but then the utmost that can be done is to cause the iron to come within a certain workable range, so that under certain conditions of management of the furnace, the iron produced will continue to be of a fairly average quality. Pure iron can never, under any circumstances, be produced in the blast furnace, but has to be obtained by the subsequent process of puddling; and though a steely kind of iron can be produced, steel properly so called, which is iron containing a definite though small percentage of carbon, cannot be made in a blast furnace. Cast iron is therefore a crude impure substance, so that in a sample of pig, in 100 parts, no more than 93 or 94 per cent will consist of metallic iron, the remaining six or seven parts comprising the various foreign matters already enumerated.

Carbon, that marvellous allotropic element which occurs in forms so diverse as the diamond, and graphite or plumbago, and almost pure in the best coke, exercises the most important influence in the determination of the quality of cast iron. This is present in two forms, either in the uncombined condition, as graphite, or in chemical combination. In what are termed grey irons, the larger part of the carbon is present in the graphitic or uncombined form. In the white irons, nearly the whole is in a state of chemical combination. When iron is mottled, the white is intermixed with the grey, and the carbon exists in both forms. The total amount of carbon present never exceeds, according to Mr. Riley, 4·75 per cent, and may be as low as 2 per cent.

The precise influence of silicon upon iron is yet under discussion. The old idea that silicon is necessarily an element of weakness, and one to be fought shy of, appears to have been overthrown by the researches of M. Gautier, Messrs. Wood, Turner, and Stead. This much is certain, that though a silicious blast furnace iron is white and brittle, yet silicon in suitable proportions may be employed as a physic for burnt and inferior irons. The tendency of phosphorus in excess is to produce brittleness, but greater fluidity, the latter being a decided advantage in fine castings. Sulphur in excess produces white iron, but in moderate amount a strong mottled iron. Manganese weakens iron.

These constituents, carbon, silicon, sulphur, phosphorus, manganese, present more or less in all pig, affect its qualities in a vital manner. But the founder, though aware of their influence, has no control of these elements; he has simply so to select, so to mix the pig and scrap which he receives, as to obtain the results which he desires. The only means he has of estimating the quality and suitability of iron is by an inspection of fractured surfaces, and by means of test bars. After that he can by means of judicious mixtures, if he knows his trade, obtain almost any grade or strength of iron which he may desire. The appearance and uses of typical kinds are tabulated below.

Grey Iron.—Characteristics: Tensile strength low, sp. gr. 7·1. Melting point, 2,912° F. to 3,542° F. Appearance: Crystals large and open, intermixed with scales of graphite; melts very fluid; surface in the ladle coarsely striated, and comparatively quiet; no sparks, scarcely any ebullition, much scum, consisting largely of graphite; runs sharp, and clean; is soft, and easily filed and tooled.

Uses.—Rain water pipes, shooting, gas and water mains and pipes, ornamental castings, grates, columns, builders' materials generally, tank plates, machine framings not having wearing surfaces, standards, bedplates, and in general all work requiring rigidity, and whose strength is largely derived from mass and judicious distribution of metal.

White Iron.—Characteristics: Tensile strength high, but destitute of toughness. Fracture, shows silvery white crystals, long and needle-like. Sp. gr. 7·5. Melting point, 2,532° F. to 2,732° F. Melts with difficulty, passing through an intermediate pasty condition; will not run in fine castings. Surface in the ladle, in violent commotion, bubbling, and throwing off quantities of sparks; little scum; hard and extremely difficult to file or tool.

Uses.—Very limited; plough shares, cams, screws of leather-dressing machines, and other small parts subject to very much frictional wear; also for conversion into malleable iron.

Mottled Iron.—Characteristics: Tensile strength and toughness high. Embraces all irons whose range is intermediate between that of the grey and white varieties, the greater proportion of white present, the more pronounced being the mottle. Hence sp. gr., melting points, and appearances may approximate to either extreme.

Uses.—Taking a good average mottled iron, it is suitable for parts requiring great strength, or subject to much wear, as engine cylinders, cylinder liners, slide blocks, cross-heads, guide bars, slide valves, machine slides, girders, gear wheels, and similar articles. In some of these cases it is not strength alone, but smoothness and durability of wearing surface, that is sought after and obtained.

We defer the subject of testing and inspection of cast work until our next. J. H.

(To be continued.)

CORRESPONDENCE.

We do not hold ourselves responsible for the opinions of our Correspondents.

THE STEAM ENGINES AND BOILERS BILL.

To the Editor of "The Practical Engineer."

Sir,—In your issue of the 29th June I notice extracts from Mr. Hiller's report as chief engineer of the National Boiler Insurance Company. Referring to the defunct Boiler Inspection and Registry Bill, it is suggested that steam users should be carefully on their guard with respect to any future legislation. Yes, but the workpeople and the general public should also be alert. I have had considerable experience of coroners' inquests on deaths resulting from explosion, and without (at present) entering into the details of such inquiries or giving any reasons for arriving at an opinion, I simply and briefly say that I have long been satisfied *that inspection ought to be compulsory;* and that, in my opinion, a simple addition to all existing Acts, such as the Factory and Workshops Acts and the Mines and Shipping Regulations Acts, compelling (under severe penalty) all steam users to have an annual thorough inspection of any description of vessels or boilers under steam pressure by a registered authority, would meet all requirements. Again, in your article on "The Practical Man" you mention instances where the good practical man has failed through sheer ignorance. I may say, in addition to your remarks, that another element has much to answer for in connection with such failures, and that is the "commercial aspect." Take the case you mention at Leeds, where the three cross tubes were taken from a Galloway boiler. The man who took out those tubes and riveted patches on, in his evidence told the jury that he had warned the engineman (who really engaged him) that the weakness of the unstayed surface was dangerous; and the engineman told him to mind his own business, or he would not get another job there. So that, Mr. Editor, this man, rather than lose a customer by intruding his opinion too far, permitted the ignorant engineman to please himself. In this instance, I have no doubt, the chief engineer of the company that insured the boiler could give you some valuable information anent annual thorough inspections.—Yours respectfully,

Bradford, 2nd July, 1888. Roger Smith.

THE FALLACIES RESPECTING THE "PRACTICAL" MAN.

To the Editor of "The Practical Engineer."

Sir,—I have read with interest your article under above title, which title I consider somewhat inappropriate. There is no doubt much truth in all you say, and a useful lesson it would be to many if they would only read and digest it, and think over the consequences of trusting such important work as engine and boiler repairs to some who call themselves "practical" men, but have no right whatever to assume that title, as they are in every sense of the word "non-practical." To such your article should have been dedicated. Boiler owners are still to be found who place implicit confidence in workmen who chance to be considered good men, and really are *good workmen*, but that qualification does not always justify their being looked upon as "practical." I met with a case a short time ago where a firm had some repairs to be done, and asked for a certain set of boiler-makers to be sent, the manager stating that he knew them to be "practical" men. The repairs were to a high-pressure boiler with double-riveted seams. A new plate was put in, and the so-called practical man went out of his way to make seams of new plate *single riveted.* Comment is unnecessary. Another case: An engineer boasted of his very wide experience (45 years in one works). He would have a boiler repaired according to his own ideas, with this result—the repairs cost about £30 more than the boiler-maker offered to lay down a new boiler for. Many other cases could be quoted; but your quotation does not appear to be a happy one, if even truthful. The boiler-maker in the case you mention practically refused to take out the tube without applying another; and in the report, No. 134, we are told the boiler-maker remonstrated with the engineer and told him it would weaken the tube; and even after the work was done he felt sure matters were somewhat serious, and again mentioned the fact, for which "the engineer ordered him out of the yard." This statement was fully corroborated by the fireman, who described the boiler-maker's mode and remonstrance, and repeated the "abusive language used by the engineer."—Yours, &c.,

July 2, 1888. Chalkline.

WORKING OF STEAM ENGINE—IMPAIRED VACUUM.

To the Editor of "The Practical Engineer."

Sir,—"Mechanical Engineer's" letter in to-day's issue should suggest to a "Young Engineer" that his coal consumption may be reduced by only working his boiler at 75lb. pressure instead of at 100lb. Of course I do not intend to convey the idea that the saving in coal will be anything like in direct proportion to the reduction of pressure—far from it; but the life of his boiler, if it is already well worked, should be much lengthened. There is certainly no advantage in generating steam at 100lb. to throttle it down to 70lb., and the slight superheating thus obtained could be better done by more direct methods.—Yours truly,

June 29, 1888. Shiny Boots.

COLLAPSE OF A FURNACE TUBE.

To the Editor of "The Practical Engineer."

Sir,—The explosion described in your publication of 22nd inst. is interesting as showing that the plates for four years past have been gradually becoming thinner, and that they have been slowly but surely approaching the thickness at which they would become too weak to sustain the working pressure. They were strong enough not to collapse when their thickness was $\frac{5}{16}$in., but not when reduced to $\frac{1}{4}$in., the comparative strengths at those thicknesses being as 25 to 16.

By Fairbairn's formula I make it that the collapsing pressure of a flue 2′-6″ diam., $\frac{1}{4}$″ thick, and 15$\frac{1}{2}$ feet long, should be 108lb. per square inch. It is well known that this formula is incorrect; but it will, perhaps, hardly be believed that it can be so misleading as to give a pressure more than double that justified by experience. It is not surprising that explosions such as the one now in question are usually supposed to be due to exceptional circumstances, though I do not see in your article that the Board of Trade Inspector has thought so in this instance, and my object in writing to you is to show that this explosion is one that might have been expected.

In January last the *Practical Engineer* (and other engineering periodicals) published a letter I sent you, giving a formula for the collapsing pressure of boiler flues, which is—

$$P = \frac{16t^2}{D^2} \text{ for flues seven or more diameters long.}$$

P being the collapsing pressure in lbs. per square inch.
t the thickness of the plates in sixteenths of an inch.
D the diameter of the flue in feet.

When the length of flue is less than seven times the diameter, the strength is inversely as the length, compared with that of a flue seven diameters long.

This would give the limit of the strength of a flue of the above-named dimensions as 45lb. per square inch, and the formula would appear to be fairly accurate, although the safety-valves were supposed to be loaded to 50lb. per square inch. If there is any error it is on the safe side, and not on the other, as in Sir W. Fairbairn's; but allowing for the increase of strength due to the taper bottom it may be said to be as nearly accurate as possible.

I do not see it mentioned that the boiler was insured, or even regularly inspected by anyone. But if we are not to be as continental manufacturers are, that is, that we are not to be trusted to use a boiler until we have first obtained the permit of a Government official, and not to be allowed to continue to use it afterwards except under the vexatious directions and restrictions of irresponsible authority, then we must cease to use boilers under conditions that can only lead to disasters, and particular care and attention should be given by the Boiler Insurance and Inspecting Companies to the old boilers still in use which were constructed before flanged and hooped flues were generally adopted.

I regret the loss of life which was caused by this explosion, and shall be glad if I can contribute to the prevention of any similar calamities in future.—I am, sir, yours truly, W. I. Ellis.

June 26.

QUERIES AND REPLIES.

Pitch of Propeller.—Can any of your readers inform me how to alter the pitch of a propeller? Suppose, for instance, a chief engineer receives orders to take the pitch of his propeller by measurement while the steamer is in dry dock, how should he proceed? A sketch would oblige.—Port Glasgow.

Answer.—In reply to "Port Glasgow" as to screw propeller, I beg to say that he cannot alter the pitch of a screw propeller blade so as to give it a proper form at every port, unless he can alter the shape of the blade itself everywhere along from its root to its point; and the conditions as to radius, pitch, and angle of blade should be as below:—

If R = radius in inches described by any point, P, in the propeller blade;
p = pitch of the propeller in inches;
A = angle of inclination of the surface of the propeller blade at the point P, with a plane perpendicular to the axis of the propeller;

then 1 $\tan A = \frac{p}{6{\cdot}2832R}$ and 2 $p = 6{\cdot}2832R \tan A$.

Where, if pitch and radius of any point be given, the angle A of that point of the blade can be found by 1.

Or, if the radius and angle of the blade at any point be given, the pitch can be found by 2.—W. A.

Setting Slide Valves.—Would any of your readers be good enough to explain the method of the setting of the valves of a common condensing marine engine (not compound)? There are two common expansion slide valves, with link motion between cylinders, fitted with hand gear. The cylinders are 24in. in diameter. and 2ft. stroke.—Amateur.

Answer.—See reply to "Basso" last week.

Drawing of a Pullman Car.—Could any reader inform me where I could get a working drawing of a Pullman car and a railway carriage?—E. P. S.

Rivet Furnace.—Can any reader of your valuable paper give me some idea of an economical rivet-heating furnace for two stationary riveting machines?—P. H.

Copper Boiler.—Could any reader inform me what would be the most suitable kind of copper boiler, with fire box, for 2½in. by 3½in. stroke horizontal engine, to be heated by a lamp or otherwise, and what would the dimensions be?—F. W. T.

Concave Circular Saw.—Can any reader describe the use of a concave circular saw? It is supposed to be attached to the end of saw spindle outside of bench and driving pulleys.—H. C.

Machine for Stamping Nails.—Will one of your readers give me the name of a good firm to manufacture a special press for stamping out nails?—F. C.

Thin Plates.—Can any of the readers of your practical and valuable paper inform me if it is possible to get thin sheets of iron or steel (say 20's gauge) as large as 8ft. 6in. by 4ft. 6in.? If so, where?—Chalkline.

Smoke-consuming Furnace.—Can any of your readers give me the address of the makers of Thompson's smoke-consuming furnace?—J. E.

Removing Black Japan from Steel.—Can any kind reader of your paper inform me as to the best way to remove black Japan varnish from steel?—Sandy.

Cement for Indiarubber.—What is the best way to cement rubber to steel?—Sandy.

TO CORRESPONDENTS.

Refrigerating Machinery.—In answer to I. F., we are not aware that there is any book published devoted exclusively to this subject.

Jamieson's Book on the Steam Engine.—We are not aware of any other book on the steam engine by this author besides the one noticed in our issue for April 27th last.

Horse-power of Engine.—In answer to "A. R.," Dewsbury, it is impossible to say what H.P. the engine is developing from the data furnished. It would be necessary to see an indicator card; and even if this were furnished, we have neither time nor space to afford for lessons such as you require. Your best course would be to get some friend to explain the matter to you.

MISCELLANEA.

Settlement of a Strike.—The dispute between the engineers employed in the Tyne shipyards and their employers was settled on Saturday, after a strike of nearly three weeks. The masters have conceded an immediate advance of 1s. 6d. all round, and an additional 6d. to men earning over 30s. a week, the latter not to take effect till a month hence.

Royal Agricultural Society.—The next meeting of the Society, which will then have completed the fiftieth year of its existence, will be held in the Great Park at Windsor, under the presidency of Her Majesty the Queen, and an influential committee has been formed at the Mansion House with a view to raise funds in order to make the 1889 meeting worthy of the occasion and completely representative of every branch of agriculture in the country.

Advance of Wages in the Cotton and Iron Trades. On the first pay day in July the cotton operatives and ironworkers in Bolton and district are to receive an advance of wages. The operative cotton spinners go up 5 per cent, strippers and grinders 10 per cent, and all other cardroom hands 5 per cent. The advance to the ironworkers will bring them up to the standard of February, 1886, for which there was the bitter and prolonged struggle last year.

Amalgamated Engineers' Society.—The annual report of the Amalgamated Engineers' Society has just been issued. It shows that the income for the last year from all sources amounted to £231,769, and the expenditure to £218,325. As indicative of the trading depression which has prevailed in the engineering trade, it is interesting to note that during the twelve months no less than £80,458 was paid in aid of members of the Society unfortunately out of employment.

Explosion on H.M.S. Benbow.—A serious explosion of coal gas occurred on board H.M.S. Benbow at Sheerness on Tuesday, the 26th ult., by which two men were seriously injured. One of the port side bunkers had just been filled and trimmed, and the men were leaving through the trap when the gas became ignited from a naked light in the hand of a seaman standing near. It is believed that the accumulation of gas was caused by damp coal, rain having fallen on it while it was being shipped.

A Large Block of Stone.—What is believed to be the largest block of stone ever quarried in this country was recently cut out of the Pilkington Quarry, Horwich, near Bolton. The block, which was without crack or flaw, measured 14ft. 6in. by 6ft. by 5ft. 3in., and weighed upwards of 35 tons. The removal of the block from the quarry to its destination at a bleachworks near Bolton, a distance of seven miles, over a rough hilly road, was effected by means of a traction engine, under the direction of Mr. Rushton, of the Phœnix Steam Boiler Company, Limited, Bolton.

Steam Railway Brake.—A continuous automatic railway brake, worked by steam, has been invented by Mr. R. H. Orton, of 11, Queen Victoria Street, London. Under each carriage is placed centrally a longitudinal brake-bar of steel, having mechanism attached to it by means of which the brakes can be simultaneously put on from either end of the train throughout its whole length. The carriages are fitted with central buffers, and are also coupled centrally. It is stated that in no case could any portion of the train become detached unless the brake-bar itself was broken as well as the couplings, and that if that took place the brakes would be locked full on.

Mogul Locomotives.—The Chicago, Burlington, and Quincey Railroad Company has recently built at its shops at Aurora a mogul to haul its fast passenger trains. Annexed are some of the dimensions of this engine: Cylinders, 19in. by 24in.; boiler of the Belpaire firebox type, straight top, without rise at firebox driving wheels, 63in. in diameter; engine truck wheels, 36in. in diameter; tender truck wheels, 36in. in diameter. The Belpaire firebox is placed on top of the frames, and is 108in. long by 3ft. 6in. wide inside. The driving wheels are about equally spaced on a 15ft. 3in. wheel base. The total wheel base is 23ft. 4in. The total weight of the engine is 48 tons.

A Useful Alloy.—According to *La Metallurgie* an alloy useful when metals are to be soldered together at a low temperature can be made as follows: Copper in a fine state of division is obtained by precipitation with zinc from a solution of sulphate of copper. From twenty to thirty parts of this, according to the hardness required, are mixed in a cast-iron or porcelain mortar with concentrated sulphuric acid, to which is finally added seventy parts of mercury, and the whole triturated with the pestle. The amalgam thus formed is thoroughly washed with water to remove the sulphuric acid, after which it is left untouched for from ten to twelve hours, at the end of which it is hard enough to scratch lead.

Solid Petroleum for Fuel.—Experiments are being carried on in Russia with the view of finding a process, at once practicable as well as desirable on the score of economy and cleanliness, of solidifying the petroleum used as fuel. According to the report made to the Russian Government by Dr. Kauffman, who has had the principal charge of these experiments, a successful method of accomplishing the desired result consists simply in heating the oil and afterwards adding from 1 to 3 per cent of soap. The latter dissolves in the oil, and the liquid, on cooling, forms a mass having the appearance of cement and the hardness of compact tallow. The product is not hard to light, burns slowly and without smoke, but develops much heat, and leaves about 2 per cent of a hard, black residuum.

A Large Span Roof.—The machinery hall of the French International Exhibition, to be held in Paris in 1889, will be covered with the largest span roof in existence. The nave of this hall will be 1,378ft. long, and the clear span will be 374ft., the height in the centre being 147ft. 7in. These dimensions are largely in excess of those of the largest existing roof in one span, that over the St. Pancras passenger station of the Midland Railway in London. This roof is 240ft. span and 98ft. high. The principals of the great French roof are pitched no less than 69ft. apart, so that the purlins exceed in span an ordinary roof. The central span is flanked by two galleries, each 48ft. broad. The floor area of the machinery hall, including galleries, is to be 565,000 square ft., or nearly 13 acres.

Parchment for Axle Bearings.—Experiments are being made on the Prussian railway with axle-boxes fitted with bearings of vegetable parchment in place of brass. The parchment is strongly compressed before being used, and it is thoroughly dried to prevent subsequent shrinkage. Wooden rings are placed on the outside of the bearings, fitting the collars of the journal. An emulsion of water and oil and all the mineral oils are used as lubricants. The parchment soon becomes impregnated with oil, and is able to go a long time without a renewal of lubrication. It is between the body of the journal and the thin edge of the parchment segments that friction takes place. The claim is made that the compressed paper bearings make a tough material that is superior to metal. Such bearings are also in use in a German sawmill, with satisfactory operation.

Oil on Troubled Waters.—An improved method of distributing oil on the waters has, says *Iron*, been patented in Germany. It consists of a rocket, to which is attached a cylinder filled with oil. It is said that the rocket can be fired with accuracy from the ship, and that, when it explodes, the oil is scattered just where it is wanted. Several interesting experiments have recently been made between Bremen and New York. In one the rocket was fired to a distance of 1,500 feet and less distances. By the explosion of five rockets at a distance of from 1,200 to 1,500 feet from the ship, a space of 1,500 to 2,000 square feet of water was covered with oil, and the waves were at once smoothed. The rocket was fired 900 feet against a gale. The importance of the invention to deep-water sailors consists in the certainty of explosion of the rocket at a sufficient distance to leave the vessel in calm water during a gale. The invention is said to have been purchased by the North German Lloyd.

SELECTED PATENTS.

APPLICATIONS FOR LETTERS PATENT.

June 22nd.

9107 Driving Belts, I. Jackson, Manchester.
9109 Lubricating Cups, T. H. Ramsden, Bramhope.
9121 Valves, H. D. Richards, Middlesex.
9125 Railway Sleepers, A. Lion, London.
9133 Consuming Smoke, R. H. Michell, London.
9136 Vacuum Gauges, J. Jackson, London.—[Complete Specification.]
9140 Tool for Cutting Metal Pipes, H. Köttgen, London.
9141 Automatic Electrifying Apparatus, C. Huelser, of the firm of Huelser and Co., London. (J. Müller, Germany.)
9147 Coupling for the Ropes of Mine Cages, C. Holcroft, Middlesex.
9150 Actuating Signals on Railways, C. E. Carr, London.
9151 Steam Boilers, P. F. Dundon, London.—[Complete Specification.]
9153 Separating Oil from the Feed-water for Steam-boilers, H. H. Lake, London. (D. Donahue, United States.)—[Complete Specification.]
9154 Valves, C. E. Gittins, London.

June 23rd.

9158 Steam Engines, A. Morton, London.—[Complete Specification.]
9171 Electric Lighting, W. E. Langdon, Derby.
9172 Pistons, W. Ford, Manchester.
9179 Locks, J. F. Thompson, Newcastle-on-Tyne.
9197 Oxidizing the Surface of Metals, G. W. Gesner, London.—[Complete Specification.]
9198 Cartridges for Breech-loading Rifles, H. W. Jeffryes, London.
9206 Galvanic Batteries, C. Lütcke and P. George, London.—[Complete Specification.]
9207 Method of Propelling Bicycles, H. Thomson, Huntingdonshire.

June 25th.

9212 Caloric Engines, J. Trewhella, Llanelly.
9220 High-speed Governors for Engines, W. Smithson and W. Pickup, London.
9224 Distribution of Electric Currents, G. Hookham, Birmingham, and R. H. Housman, Worcestershire.
9225 Automatic Air Injector, S. Sheppard, F. Hazlett, and S. J. Cluff, Dublin.
9229 Automatic Steam-reducing Valves, E. Whiteley, of the firm of W. Whiteley and Sons, Huddersfield.
9235 Carding Machines, G. Josephy, London.
9241 Automatic Brake for Perambulators, T. V. Riordan, London.
9249 Governors for Gas Engines, E. F. Delamare-Deboutteville and L. P. C. Malandin, London.
9252 Blow Pipes, A. B. Coleman, London.
9253 Blast Furnaces, E. Walsh, jun., London.—[Complete Specification.]
9258 Locomotives, F. Engel-Gros, London.—[Complete Specification.]
9271 Jointing Pipes, A. C. Emery and W. H. Tylor, London.—[Complete Specification.]

June 26th.

9275 Roller Mills for Crushing Minerals, A. H. Wallis, Hampshire.
9277 Electric Automatic Annunciator, H. Binko, London.
9278 Jointings of Pipes, T. Feather, Keighley.—[Complete Specification.]
9287 Rotary Engines, R. McCracken, Belfast.
9290 Steam Boilers, J. Rankine, North Shields.
9291 Ships' Propellers, C. Spinks, Glasgow.
9297 Vices, G. H. Richmond and J. Whetnall, London.
9308 Dynamo-electric Machines, J. Edmondson, London.
9310 Gas Engines, J. Roots, London.
9311 Hydro-carbon Engines, J. Roots, London.
9313 Hydraulic Brakes, A. Longsdon, London. (The firm of F. Crupp, Germany.)—[Complete Specification.]
9316 Grips for Cable Railways, A. J. Boult, Middlesex. (B. D. Dougherty, United States.)—[Complete Specification.]
9324 Preventing Scale in Steam Boilers, J. W. C. Hamilton, Liverpool.
9329 Petroleum Lamps, J. A. Lee, London.
9333 Electric Arc Lamps, H. Pidot and H. Pautier, London.
9337 Marine Propulsion, W. M. Jackson, London.—[Complete Specification.]
9338 Pulverising Flint, W. Boulton, London.—[Complete Specification.]
9340 Motive-power for Propulsion, G. Wald and E. Rigal, London.—[Complete Specification.]
9343 Mitreing Bench and Vice, F. Hodges, London.

June 27th.

9345 Electrically-propelled Boats, R. R. Hutchinson, London.
9347 Locking the Doors of Railway Carriages, F. H. Berry, London.
9351 Couplings for Railway Vehicles, G. Newman, Liverpool.
9352 Coupling Pipes, A. A. A. Muller and G. A. P. Roger, London.
9363 Gas Burners, W. H. Pike, Newcastle-on-Tyne.—[Complete Specification.]
9365 Copper Boilers, L. Marshall Halifax.
9369 Preparation of Oils, J. Campbell, Dundee.
9371 Sewing Machines, T. M. Cockroft and R. Farmer, Sheffield.
9381 Electric Batteries, A. Imschenetzky, London.
9382 Carding Engines, J. E. Platt and J. Fidler, Manchester.
9386 Stop Valves, W. N. Baines and R. T. Baines, London.
9388 Pipe Joints, A, Ramsden, London.
9390 Lubricators, G. Cowdery, T. Perry, and J. B. Hyslop, London.—[Complete Specification.]
9393 Type-writing Machines, J. Fleming, London.
9394 Dredging Apparatus, — Letellier and — Grandin, London.
9395 Dredging Apparatus, — Letellier and — Grandin, London.

June 28th.

9405 Electrical Accumulators, R. F. Yorke, Surrey.
9412 Locking Nuts of Rails of Railways, J. T. Kerby, Westminster.
9413 Hydraulic Rams, T. O. Molesworth, London.
9415 Combined Motor, J. Cowan, Glasgow.
9416 Boilers, J. Hartley and J. E. Aspinall, Manchester.
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9433 Bicycles and Tricycles, J. Toy, Cornwall.
9439 Caloric Engines, C. Wells, Middlesex.
9451 Stop Cocks, J. A. Hopkinson and J. Hopkinson, of the firm of J. Hopkinson and Co., London.

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Vol. I. (bound), containing Nos. 1 to 44 inclusive, from March to December, 1887, price 6s. 6d., can still be obtained by order from any Newsagent, or will be forwarded, carriage paid, from either of our offices on receipt of the amount by postal order or stamps.

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EDITORIAL NOTICES.

All communications for the Editor of this Journal should be addressed to 6, Victoria Station Approach, Manchester.

Communications intended for insertion in the current week's issue should reach us not later than Tuesday Evening.

We cannot undertake to return rejected manuscripts or drawings unless accompanied by a stamped and directed envelope.

Contributors are requested to write on one side only of the paper. Sketches should be sent on separate sheets.

TO ADVERTISERS.

Advertisements intended for insertion in the current issue should reach us on Wednesday morning at the latest.

THE
PRACTICAL ENGINEER.
JULY 13TH, 1888.

COMMERCIAL MORALITY.

THE criminal proceedings arising out of what was known as the Salford Gasworks Scandal came to a termination at the Old Bailey on the 5th inst., when Mr. Samuel Hunter, the late manager of the Salford Gasworks, was sentenced to five years' penal servitude.

The sentence may perhaps appear a severe one, but taking the whole of the circumstances into account, we cannot regard it as one whit too heavy. The offence, or rather series of offences, for which Mr. Hunter was punished were such as no English judge could lightly pass over, and it was desirable on every ground that the punishment inflicted should be an exemplary one.

It will be remembered the proceedings arose in the first instance out of an action for libel brought by Mr. Hunter, who was then manager of the Salford Gasworks, against a Mr. Lever, of Manchester, for statements which Mr. Lever had made in a letter written to a member of the Salford Corporation, to the effect that Mr. Hunter was in the habit of accepting commissions in connection with the contracts for coal; that the placing of the orders was largely determined by the amount of commission; and that the ratepayers were in consequence defrauded.

At the trial Mr. Hunter stated on oath, over and over again, in the most solemn manner, that the charge of accepting commissions was without a shadow of foundation, and it is very probable that but for the startling intervention, at the last moment, of a witness who happened to be in court, and whose evidence was quite unexpected by both sides, Mr. Lever would have had a heavy pecuniary fine inflicted upon him, even if he had not been sentenced to a term of imprisonment as a common libeller. The evidence of the witness, however, dispelled, at a stroke, the whole of Mr. Hunter's case, exposing at one and the same time the terrible nature of the wrong he sought to inflict on an innocent man, as well as the lengths he was prepared to go to compass his own ends and hide his own guilt.

Commencing with the acceptance of commissions, or rather with their exaction—for it has been pretty clearly proved since that in the matter of the coal contracts he had the unstinted confidence of the Gas Committee, such confidence we may say, by the way, as no corporation was justified in reposing in a public servant without further check—he was very largely able to dictate his own terms, and did not hesitate, when necessary, to forge the name of the Chairman of the Committee, to make it appear that the acceptance of commissions was a part of the Salford Corporation's regular method of transacting business. The crime of forgery he sought to conceal by committing the still more heinous offence of perjury—perjury, too, be it remembered, of the most horrible kind, and with every form of aggravation, for it was committed not merely to hide his own delinquencies, but with a view to crush and overpower an innocent man; while the fact of his instituting criminal rather than civil proceedings for libel against Mr. Ellis Lever effectively closed the mouth of that gentleman, and rendered him least capable of defence. Looking at the case altogether, we fail to detect a single redeeming feature; and however sad the contemplation of the fall of a man from a trusted and honoured position may be, considerations of pity should not be allowed to interfere with justice, and, after making every allowance, we cannot regard the sentence as excessive.

The extent to which the ratepayers of Salford were defrauded by Mr. Hunter's malpractices will probably never be known. The public curiosity has been excited in consequence of the prolonged interval that has intervened between the trial and the passing of sentence. The date upon which it was to have been given has been more than once postponed, with a view to the result of certain Chancery proceedings instituted by the Corporation against Hunter being first made known—a delay we think, on public grounds, very much to be regretted and liable to misinterpretation. However, from what was stated on the day of sentence, it would appear that Hunter declined to make any voluntary restitution of his ill-gotten gains, and we are afraid the endeavour to effect a forced one will be very much like the proverbial attempt "to extract butter from a dog's throat."

The history of the case, so far as it is known, is calculated to give rise to a somewhat uncomfortable feeling in the minds of business men, especially when taken in conjunction with the scandalous system of blackmailing now being laid bare by the Royal Commission appointed to inquire into the working of the Metropolitan Board of Works. We would, however, deprecate the assumption that venality of the kind revealed is common and widespread, that corruption and bribery are necessary to success in business, and that honest men are few and far between. We are not of those who contend that the standard of morality in commercial matters has fallen. On the contrary, we maintain that that standard was never higher than it is to-day, jerry building, China clay sizing, and Royal Commission revelations notwithstanding.

Whatever other evils may be developed by the keen competition which prevails now-a-days in commercial matters, bribery, at least, is not of them. The natural tendency of the struggle is to bring producer and consumer into closer contact, and eliminate more and more everything in the nature of bribes and commissions as a useless tax upon trade that can very well be dispensed with. Every buyer seeks the best and the most he can obtain for his money, and "tipping" is a kind of generosity in which the present narrow margins will seldom allow a seller to indulge. There are fewer idle people in the world, and the room for such gets less as time goes on. The old law, "If thou wilt not work neither shalt thou eat," becomes more apt every day, and success in business, in the long run, can only be attained by honest industry and perseverance. Rogues and humbugs may flourish for a time, but sooner or later they are found out, and learn to their cost that the way of transgressors is hard, and that honesty, after all, *is* the best policy.

THE WHITWORTH ENGINEERING SCHOLARSHIPS.

One result of the recent conversion of the 3 per cent Consols to 2¾ per cent has been to reduce by £250 the sum of £3,000 hitherto annually available for the Whitworth Engineering Scholarships, and to provide which the executors of Sir Joseph Whitworth paid in consols to the Science and Art Department the sum of £100,000. Sir Henry Roscoe put a question in the House of Commons regarding the matter to the Chancellor of the Exchequer, and asked whether he was aware that, in consequence of the National Debt Conversion Act, the income for the scholarships which the Science and Art Department expressly undertook to keep up, was thereby reduced by one-twelfth, and whether he would undertake that the difference should be paid to the foundation from public sources, so that the original sum of £3,000 per annum agreed upon between the Science and Art Department and the executors should be made up from year to year. In his reply, the Chancellor of the Exchequer, while admitting the accuracy of everything stated in the question, declined, we are sorry to say, to comply with it on the ground that, if the difference were made up in the case of this endowment, it would open up the flood-gates to an ocean of similar claims on behalf of other trusts whose income had been diminished in a similar way, and that such a prospect could not be lightly contemplated. We must say that we cannot consider Mr. Goschen's answer as satisfactory by any means, and we trust Sir Henry Roscoe will not allow the matter to rest where it is. There was a distinct agreement on the part of the State that the income of £3,000 available for the scholarships should be preserved free from all deductions and abatements, and the attempt to slide out of a solemn obligation on the grounds put forward by the Chancellor of the Exchequer can only be fitly characterised by words we would rather not use, and the State, of all parties, should be the last to commit such an act of appropriation. Let us have retrenchment wherever possible, but by all means let it not be effected by the breaking of solemn pledges and the repudiation of sacred trusts, for that, in reality, is what the proposed reduction in the grant amounts to.

THE RIBBLE NAVIGATION SCHEME.

The Preston Corporation Bill has been again under the consideration of the House of Commons Select Committee, and further evidence was given for the promoters on the commercial aspects of the Ribble scheme. Mr. Higson, of the firm of Messrs. T. Higson and Co., Blackburn, manufacturers and timber merchants, said he anticipated that the improvement of the navigation of the Ribble would be of great advantage to the timber trade. A considerable portion of the timber now used in North-East Lancashire was imported at Liverpool and Barrow, and he was of opinion that much of this traffic would be diverted to Preston. Mr. Charles Rowe, chairman of the Preston Union Bank, and a coal merchant, was of opinion that the scheme was vital to the prosperity of the town, and ought to have been undertaken years ago. If the works were delayed much longer the port, he thought, would be ruined; but he admitted that unless there was a good channel between Preston and the sea, the docks would not be of much service. Mr. Marshall Stevens, manager of the Manchester Ship Canal Company, expressed the opinion that there was no port in the United Kingdom with a population of 100,000 that would not be justified in expending £1,500,000 in securing an effective navigation. He estimated that there would be sufficient revenue from shipping at Preston to pay 4 per cent on the outlay. Apart from direct pecuniary advantages, he was of opinion that Preston would be justified in incurring a large expenditure for the sake of the indirect advantages that would be derived. Mr. Stevens said he estimated that 800,000 tons of shipping would be required to pay interest on an expenditure of £1,500,000. That amount of tonnage would realise a gross revenue of £92,000 per annum. This was upon the basis of enabling Preston to compete with other ports. At 4 per cent the interest on the estimated expenditure would be £60,000 a year, and dredging and maintenance would take £20,000 a year. He expected a traffic of 800,000 tons would be secured within three or four years. Mr. Deas, engineer to the Clyde Navigation Company, was next called. He said he was well acquainted with the Ribble. His opinion was that when the dredging from Preston to Lytham had been completed the tendency of the current would be to improve the channel. In the course of some discussion as to the probable duration of the inquiry, the Chairman pointed out that by the consent of both parties Mr. Abernethy had been appointed to report on the scheme, and looking to that fact and to his eminence as an engineer, the Committee would be much more guided by his evidence than by that of other engineers. Mr. Deas expressed the opinion that the works already authorised, and those provided for by the present bill, would give a good workable access to Preston for vessels of 22ft. draught. After some further discussion, the Committee was again adjourned.

COMPOUND v. SINGLE-CYLINDER ENGINES.

The following notes of a lecture delivered by Mr. R. E. Burcham, of Manchester, before the Ashton-under-Lyne Engine-keepers' Association, on the above subject, will prove of considerable service to those of our readers who have to do with the working of steam engines, but do not possess the requisite mathematical knowledge to enable them to follow the ordinary text books on the subject, and will doubtless prove interesting to our general readers as well.

The lecturer said he did not claim novelty for the arguments adduced, but his object was to impart a clear general conception of the principles and advantages of the compound engine. This was illustrated graphically in every point, either by diagrams drawn to large and uniform scales for "eye comparison," or by proportionate sketches on the blackboard, while lettered formulæ and technical words that might not be understood by every one were carefully excluded.

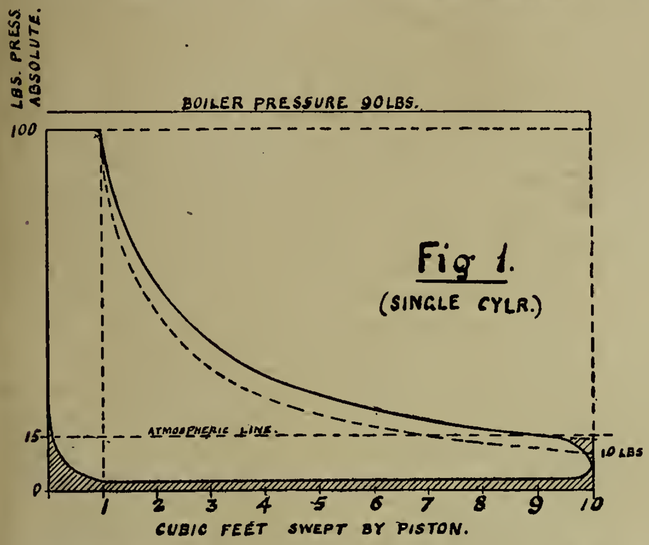

Fig 1.
(SINGLE CYLR.)

The necessity of working steam expansively in order to obtain economy was clearly illustrated, and attention was called to the variations of temperature in engine cylinders, and to the losses arising from "initial condensation," that is, condensation during admission of hot steam to a comparatively cool cylinder. It was also shown that the "clearance steam" only does work during the period of expansion, and not during the period of admission.

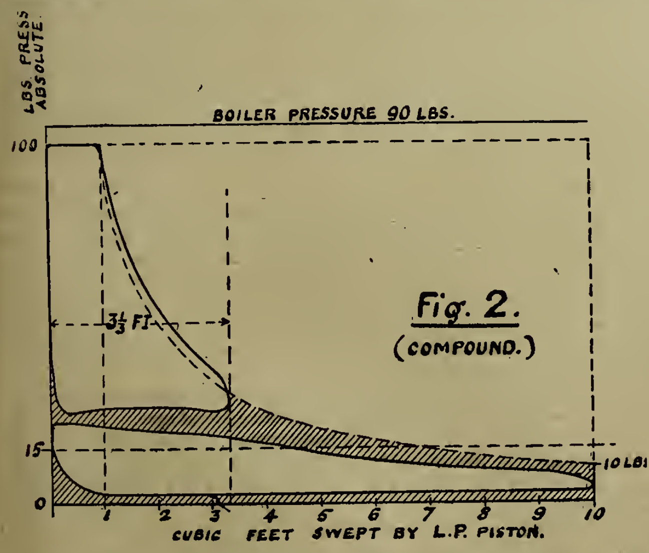

Fig. 2.
(COMPOUND.)

By reference to a table of temperatures of steam at various pressures, ranging from 2lb. absolute to 120lb., it was shown that the loss of one degree in the temperature of steam at a high pressure was accompanied by a greater fall of pressure than the loss of a degree of heat at a low pressure; while mention was made of the advantage of high piston speed, and also of the utility of the steam jacket.

The lecturer next proceeded to explain that the capacity of a compound engine was measured by that of the low-pressure cylinder, and not by that of the high-pressure and low-pressure cylinders combined, as was sometimes supposed. Diagrams were also shown taken from both cylinders of compound engines on the same card, and with the same spring, and in which the lengths of the high and low pressure diagrams were proportioned to the relative volumes of the cylinders.

By means of large diagrams a comparison was drawn between the work done in a single-cylinder engine, whose piston sweeps through 10 cubic feet per stroke, and a compound engine in which the low-pressure piston sweeps through 10 cubic feet, and the high-pressure piston $3\frac{1}{3}$ cubic feet per stroke, the ratio of capacities being thus as 3 is to 1. These diagrams, which are very interesting, we have reproduced (see figs. 1, 2, 3, 4). In each case the indications would seem to show that 1 cubic foot of steam at 100lb. absolute pressure is admitted to the engine, the cut-off in the single-cylinder being at one-tenth of the stroke, and in the high-pressure cylinder of the compound engine at a little before one-third of the stroke (see figs. 1 and 2), so that there are the same number of expansions in the single-cylinder as in the compound engine. If both engines were without clearance spaces, and if no steam were condensed in either engine during the period of admission, the same terminal pressure, viz., 10lb., might be expected in each case, whereas in practice this is not so. In the compound engine diagrams there is a gap or loss between the back pressure in the small cylinder and the forward pressure in the large cylinder; also there is a considerable drop from the high-pressure terminal to the back pressure, so that the low-pressure diagram seems much "leaner" than it should be and the terminal pressure, instead of being 10lb., is but little over 8lb.

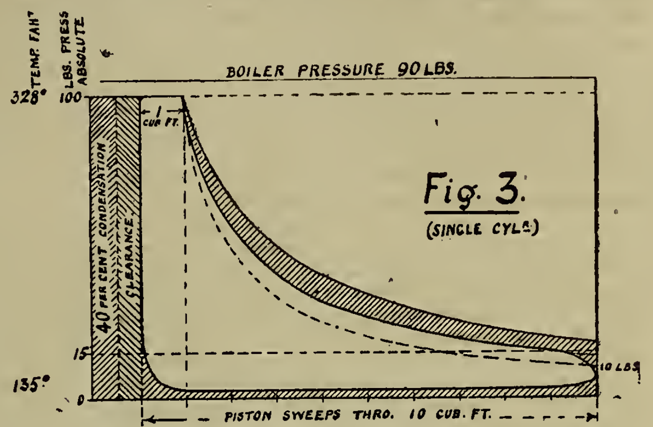

Fig. 3.
(SINGLE CYL^{R}.)

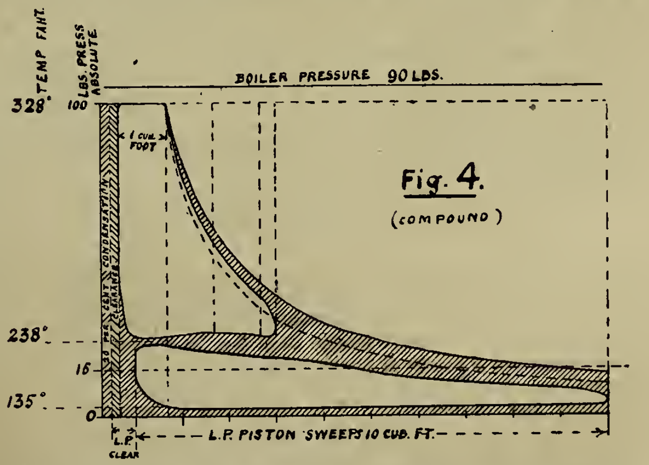

Fig. 4.
(COMPOUND)

On the other hand, we find the diagram from the single-cylinder somewhat fuller or larger than was expected, and the terminal pressure is 13lb. to 14lb., instead of 10lb. This result makes the compound engine *apparently* much less economical than the single-cylinder. The word apparently is italicised because very few engineers now believe this to be a fact.

The lecturer, in explaining how the discrepancy occurred, pointed out that an indicator, although a useful instrument, did not give any measure of the amount of steam admitted to an engine, but only showed the pressure exerted upon the piston at the different points of the stroke, and at what point in the stroke the cut-off occurred. Referring to figs. 3 and 4, it will be seen that the amount of steam admitted to each engine, in addition to the 1 cubic foot already taken account of, is as follows: First there are the clearance spaces to fill; and if 5 per cent be allowed in each case, then for the single-cylinder this will amount to 5 per cent of 10 cubic feet, or half a cubic foot; whilst for the compound engine it only amounts to 5 per cent of 3½ cubic feet, or ⅙ of a cubic foot. In addition to clearance, there is the amount required for initial condensation. These amounts cannot be calculated exactly, but, for the purpose of illustration, they may be estimated in accordance with the results of experiments quoted in D. K. Clark's Rules and Tables (page 880) as at least 40 per cent of the 1·5 cubic feet initial volume = 0·6 cubic feet for the single-cylinder engine (where there is a range of 193° temperature and ten expansions in the one vessel), and not more than 20 per cent of the 1·16 cubic feet initial volume = 0·233 cubic feet for the compound engine (where there are only 3½ expansions in the first cylinder and a range of only 90° in the same vessel).

From this, therefore, it would appear that instead of both engines having received similar amounts of steam—viz., 1 cubic foot each—the single-cylinder received

$$1 + 0{\cdot}5 + 0{\cdot}6 = 2\tfrac{1}{10} \text{ cubic feet of steam,}$$

while the compound engine only received

$$1 + 0{\cdot}166 + 0{\cdot}233 = 1\tfrac{4}{10} \text{ cubic feet of steam.}$$

On diagrams Nos. 3 and 4 are drawn hyperbolic curves, from which may be seen the proportion that the areas of the indicator diagrams of useful work bear to the areas of diagrams that should be obtained from the respective amounts of steam had there been no loss from clearance or initial condensation, &c. The single-cylinder diagram shows a useful mean pressure of about 34lb. with a consumption of 2·1 cubic feet of steam at 100lb., while the compound diagrams show an equivalent mean pressure of about 26lb. for a consumption of 1·4 cubic feet of steam at the same pressure. It will be seen, therefore, that the result of the comparison is decidedly in favour of the compound engine.

It should be remarked that what losses there are arising from "clearance" and "initial condensation" in the low-pressure cylinder of the compound engine are accounted for in the shaded portion of fig. 2, and also of fig. 4.

Some writers argue that the steam condensed during admission before "cut-off" is re-evaporated and does duty during expansion, and no doubt this is true to some extent, but the most likely time for such re-evaporation is during "exhaust," when the lowest temperature is reached; and hence much of the steam of re-evaporation in the single engine, instead of doing work during the stroke, is simply carried off to the condenser. Now, in the compound engine any re-evaporation that occurs during the exhaust stroke of the non-condensing cylinder must help to feed the low-pressure cylinder, and thus perform useful work; so that any loss due to initial condensation in the high-pressure cylinder of a compound engine is to a large extent recoverable.

The lecturer then proceeded to discuss briefly the strains on the piston rods, frames, &c., of the hypothetical single-cylinder and compound engines referred to, and stated that if the compound engine, now arranged as a "tandem," *i.e.*, one cylinder behind the other, the stresses in the compound would be fully 40 per cent less than in the single-cylinder engine.

THE LOEB RESPIRATOR.

Some interesting experiments have been recently carried out with the Leob respirator. The chief object was to demonstrate that any one provided with the apparatus could safely move about for some time in the densest smoke and also in poisonous vapours. The apparatus consists of a metal respirator having two cylinders containing the filtering medium and a system of valves for inhaling and discharging. The respirator is supported by an elastic band passing round the head, the whole weighing only 15oz. An ingenious pair of spectacles is employed to prevent the eyes being affected by the smoke or vapours. The nose is closed by means of a small clip to protect the nostrils, and the whole apparatus has been designed for household use as well as that of firemen and policemen. Other forms have been devised for mines, chemical works, sewers, and other places where noxious gases abound. A dense smoke was created in a closed iron building in which several gentlemen, equipped with the apparatus, remained for some minutes at a time. Another building was charged with the fumes of burning sulphur, and in this asphyxiating atmosphere two gentlemen remained for some time, thus demonstrating the value of the Leob system, which is being introduced by the Fire and Mining Appliances Syndicate, of 19, Queen Victoria Street, London.

MACHINERY FOR THE STEELWORKS AT TERNI.*

The new steel and iron works at Terni, in Central Italy, were begun under the auspices of the Italian Government in 1884, with a view to make that country independent of foreigners in the matter of heavy guns, armour plates, and other requirements of modern warfare.

The works are the property of a company, and Terni was selected as the most suitable site, principally on account of the cheap and inexhaustible source of motive power present in the neighbourhood, in the shape of numerous waterfalls, notably the celebrated "Marmore" cascade, a fall of the river Velino, on which the town is situated.

Another local circumstance of considerable importance lay in the almost immediate proximity of large beds of lignite, possessing gas-producing properties which make it valuable as a fuel for melting and reheating furnaces on the Siemens principle.

A short distance above the Marmore cascade the water for supplying the motive power to the new works is diverted from the course of the Velino, and brought by a canal to the interior of the works, where an arrangement of pipes and sluice valves regulates its flow to the different turbines and water engines by which its power is utilised. The quantity of water that can be drawn from the river is sufficient to develop a force of 8,000 effective H.P. The total height of fall from the level of the Velino to that of the floor of the works is about 750 feet. The length of the canal amounts to 7,217 yards, of which 2,900 yards are in a tunnel driven through an intervening mountain, with a section of 6ft. 6in. in height by 5ft. 9in. in width. Other works of considerable magnitude had also to be carried out.

At first sight it would appear doubtful whether, in presence of so great an outlay, the use of steam in preference to water engines might not have been more economical. The great available fall, however, was an important factor, by reason of the very high pressure at which it could deliver the water for use, which allows of great economy in the construction of the machinery, by the use of turbines or water engines of high power, but of comparatively small dimensions.

The loss of pressure due to the length and sinuosities of the canalisation and to all other causes amounts to about two atmospheres, and an effective pressure of from eighteen to twenty atmospheres may be reckoned on in the interior of the works.

The turbines are, as a rule, directly coupled to the mills, hoists, cranes, machine tools, or other appliances they have to work.

The machinery at Terni has been supplied mainly by Belgian, French, and Swiss makers, and comprises the forging plant necessary for the production of great guns and armour plates. This consists of a 100-ton dead-weight hammer, with cranes having sufficient power for lifting and handling steel ingots weighing from 100 to 150 tons, and pumps and engines required for the production of the compressed air used in working these appliances. This forging plant is at present the most powerful of its kind in existence on the continent of Europe.

The original motive power here, as throughout the whole works, is hydraulic, the air compressors being driven by special water-power engines, and the machinery here described may be considered as the result of many years' experience in work of its kind.

The chief advantages of compressed air consist, in the first place, in the easy transmission of power to great distances which it affords, with comparative immunity from certain causes of loss, such as leakage in pipes, as compared with water, or condensation as compared with steam. A second advantage of great importance is the possibility of having a reserve of power always at hand, without having recourse to continuous pumping, by simply establishing reservoirs of air under pressure, which can always be kept full, the air being ready for use at any time.

The great size and capacity for work of the machinery at Terni give far more than usual value to these advantages.

The objections to the use of compressed air—viz., loss of power in compressing the air owing to the heat developed, and subsequent further loss while doing work in the motor, through cooling and rapid fall of pressure (especially if used expansively)—lose much of their weight when the power producing the compressed air in the first instance is an almost costless natural force, as at Terni.

The air-compressing machinery consists of three sets of François and Dubois compressing pumps. Each of these consists of a pair of air cylinders, 31½in. in diameter and 47¼in. stroke, worked by water-pressure cylinders 14in. in diameter. The machinery runs at a maximum speed of twenty-four double strokes per minute, the motion being kept as uniform as possible by causing the engines of each set to work on a shaft with cranks at right angles, between which a large flywheel is carried. Each stroke of a compressing piston delivers 3·39 cubic feet of air, at a pressure of 90lb. per square inch. The total power developed by the four sets of compressors will be little short of 2,000 I.H.P., and 1,871,748 cubic feet of air, at an effective pressure of 75lb. may be supplied every twenty-four hours, the compressors working to their full capacity. The compressed air is forced into a cylindrical sheet-iron reservoir, 5ft. 3in. in diameter, by 16ft. 5in. in height, from which it is led through pipes to the hammer and the crane engines. In order to maintain a constant pressure and ensure a regular motion of the engines, the reservoir communicates at all times with a special regulating apparatus. This consists of two large mains, built up of cast-iron pipes, 4ft. 1in. in diameter, each having a total length of about 1,300ft. The total capacity of these mains or pressure regulators is about 35,000 cubic feet; the air they contain is kept constantly at a uniform pressure by means of cast-iron siphons 2ft. in diameter, opening at one end into the regulators, and at the other into a large water tank, placed at a height of 167ft. from the ground, and maintaining consequently in the regulators a pressure of about 75lb. above the atmospheric pressure.

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* Proc. Inst. C.E. Paper by Hugh Savage, Assoc. M. Inst. C.E.

These siphons lead water from the tank into the regulators, the water taking the place of the air withdrawn, and thus the same pressure can be maintained with widely-different volumes of air in the regulators.

The different supply pipes all branch off from a single large main running longitudinally on one side of the building, and 30in. in internal diameter. This main is filled with a very large air vessel to deaden any shocks resulting from a sudden turning on of the water at so high a pressure. The differences in piston speed at the middle and ends of the stroke, and their possible effects on the pipes and moving parts, are provided for by a special air buffer. This air buffer consists of a short ram, to which the water in the main transmits its pressure directly. The upper end of the ram carries a piston which can move up and down in a cylindrical vessel, its upper surface being subjected to an air pressure of 75lb. per square inch. The sections of the ram and piston are such as to be in equilibrium under normal pressures of air and water. Directly the slower motion of the piston towards the end of its stroke causes the pressure of the water to increase, it forces up the ram, compressing the air in the upper vessel; and inversely, when the water pressure decreases, which happens at about half-stroke, the air forces down the ram, restoring the pressure to its normal amount.

These engines work at a maximum speed of twenty-four double strokes per minute, equivalent to a piston speed of 3ft. 3in. per second. The cylinders are made with very hard cast-iron liners $1\frac{1}{4}$in. thick, in order to resist the wearing effect of dirty water. Great difficulty was experienced in providing both valves and pistons with a satisfactory packing. The erosive action of the sand-charged water, under the very high pressure worked at, was so destructive that no metallic packing could be made to withstand it, the rings wearing out in a few days in spite of a most liberal provision of rubbing surface. This difficulty was at last overcome, after several attempts, by the use of leather. The valve packings consist of flat rings of leather placed one above the other, and kept in position by means of iron caps with through bolts. The main pistons have packing rings of compressed leather identical in principle to those used in hydraulic presses. By the adoption of these contrivances, the water engines have been brought to work in the most satisfactory manner, the dirty condition of the water being no longer a serious source of trouble.

Great strength is given to all parts of the engine, which are mostly made of steel, on account of the extra strains to which they may at any time be liable, through shortness of water and consequent dead spaces in the cylinders, which spaces are liable to become filled with compressed air. Besides the precautions taken against wear, by the use of leather packings, as already noticed, the piston rods of the water engines are guided at both ends so as to relieve the piston and glands.

The great advantage of water engines consists in the facility they offer for adopting a convenient speed for the purpose in view without necessitating the use of gearing, and in considerably greater simplicity of construction.

The mechanism of the inlet valves of the air cylinders has also been improved, so as to admit of a more rapid action, and to make this action more perfect by preventing the valves from jumping on their seats. The valves are placed in pairs at the upper part of the discharge columns, and open outwards into a kind of trough placed above the cylinder, which receives the discharged water as before mentioned. Each valve consists of a flat wrought-iron disc with a leather facing; the valves are fitted in pairs, one at each end of the cylinder on the same spindle, carried on two small oscillating fingers of steel. The spindle itself is in two parts, held together by a spiral spring, acting so as to draw the two parts of the spindle towards each other, and so hold the opposite valves firmly on their seats, except at the moment when the pressure of the air forces them open. In this way the opening of one valve is simultaneous with the closing of the opposite one, and there is no jumping of the valves. The discharge valves are of the ordinary pump valve type.

At each end of the cylinder provision is made for injecting water into the interior. This water is intended to replace that expelled from the cylinder, and to cool the air during the process of compression.

For this purpose the water is reduced to a state of impalpable spray, in which condition it intermingles more intimately with the air. A small quantity of oil is usually added to the water. The refrigeration of the air thus effected is a point of the greatest importance, as no system of cooling from the exterior could be expected to prove efficient with so large a cylinder. The quantity of water injected at each stroke is equivalent to $\frac{1}{10}$ of the volume of the cylinder, and the temperature of the air is maintained at from 50° to 70° centigrade.

Supplying air at a pressure of 90lb absolute, these compressions gave a useful effect of from 90 to 92 per cent of the power developed by the engines. This is a very high result, and proves that in many cases compressed air, with the advantages peculiar to it, may be even economically superior to steam, although steam power be used in its production.

LUBRICANTS FOR HEAVY MACHINERY.

The following are some of the lubricants that have been advantageously used with heavy machinery:—

A mixture of oil and soft soap does very well for the lubrication of parts running under water, especially sea water.

Coal tar, resulting from the distillation of coal gas, may be used on the teeth of heavy gearing.

Plumbagine (powdered carburate of iron) may be used alone or mixed with tallow. When used in the latter way, five parts of tallow are mixed with one of plumbagine.

It is prepared by melting the tallow in an iron kettle, into which the plumbagine is slowly poured, care being taken that the ingredients become well mixed. It is used cold.

Oil saponified with lime or soda makes a fair lubricant. The proportions of the component parts of one variety are resin oil 52lb. and hydrate of lime 36lb.

A number of years ago a French railway used a saponified palm oil on their car axles, that was in the form of a soft soap. The oil was saponified with soda, and was prepared to suit the season during which it was to be used. It melted readily in winter, while that used in summer could resist the elevated temperature of the atmosphere and heat due to friction. The following is the recipe:—

		Proportions of	
	Summer.	Spring and Fall.	Winter.
Palm or other vegetable oil.	10	30	45
Purified commercial tallow.	50	30	15
Water	30	36	38
Carbonate of Soda	10	4	2

Another recipe is:—

		Proportions of	
	Summer	Spring and Fall.	Winter.
Palm or vegetable oil	62·50	75	87·50
Tallow	87·50	75	62·50
Soda	25·	25·	25·

Dissolve the soda in four gallons of water; pour this solution into a wooden tub containing from 30 to 40 gallons of water, and stir it well. Melt the tallow; add the oil to it, and boil for a moment together; allow the mixture to cool until the hand can be held in it; strain the mixture of oil and tallow through a sieve into the tub of soda and water, and stir well to make it homogeneous; keep the portion that solidifies and pour off the water.—*Power and Steam.*

Cable Tramways.—Owing to the great success of the cable tramway at Birmingham, it is proposed to extend the line to Handsworth, about 3,000 yards beyond the borough boundary. The work is to be commenced forthwith, and is expected to be finished before the end of the year.

THE GLASGOW EXHIBITION.

FROM OUR SPECIAL CORRESPONDENT.

(Continued from page 304.*)*

Visitors to the Exhibition cannot fail to notice while passing along the east side of the Machinery Annexe, under the gallery, the very prettily arranged stand of Messrs. Schaffer and Budenberg. The name of this firm is quite familiar to all interested in steam, and so to a certain extent are their manufactures; but something more than a passing glance is required to gain an idea of the features attached to each of their numerous specialties.

First and foremost we observe gauges from four to twelve inches diameter, for recording steam and hydraulic pressures. Those on the Bourdon principle have of late had some improvements introduced into them to adapt them to the high pressures now used. The latest improvement is a steel tube instead of a brass one. These tubes are made from a special quality of steel rolled into bars, then turned and accurately bored out; they are afterwards gently heated and shaped oval, except at the ends, where they are left round, and screwed. See fig. 1, where the gauge has an open front to allow of the spring being always seen. For steam gauges the tubes are tinned both inside and out, that they may the better resist the corrosive action to which they are subjected. The peculiar section and shape of the tube is a special feature of its accuracy, and it is to these points that the makers appear to have bestowed so much time and care. The marking and adjusting of the gauge, so as to record a correct pressure, is the next and most important step for consideration, and in this lies the intrinsic value of a good gauge.

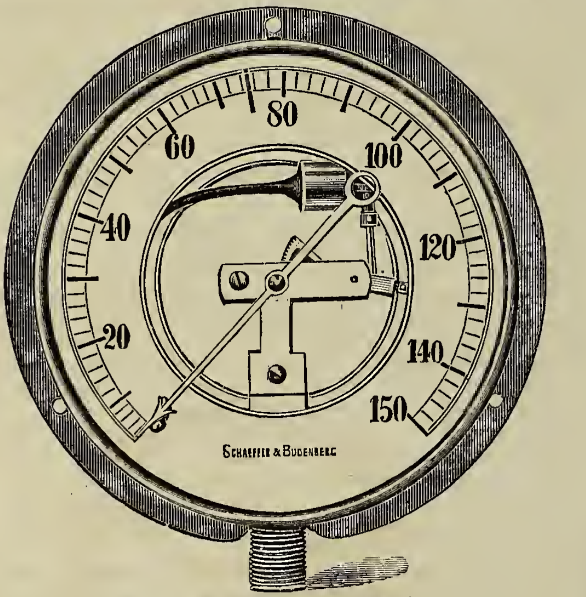


Fig. 1.—Patent Steel Tube Gauge.

We have heard of gauges being sold that could certainly not have been tested, for when put in their places they were so much out as to be worse than useless. Others, again, test new gauges against a standard one, which may be right enough so long as the standard one is correct.

Messrs. Schaffer and Budenberg test all their steam gauges before leaving the works against a mercurial column. The dials are then marked off accordingly. They are afterwards tested under steam, if necessary up to 400lb. per square inch, and allowed to stand for a time, that any variations may be noted. The hydraulic gauges are similar in principle, and tested by a special apparatus up to any required pressure; they have been made for the Royal Arsenal, at Woolwich, for pressures as high as 50 tons per square inch.

The standard duplex gauges have two pointers working one dial in opposite directions; one thus acts as a check upon the other. Gauges of this description are used for the hydraulic testing of boilers to twice the working pressure, and it will be at once seen the absolute necessity for the pressure being correctly registered to a pound. Where great pressure is not required, for vacuum gauges, &c., the tubes are made of brass.

The maximum pressure-recording gauge is for the purpose of ascertaining the highest pressure to which the gauge has been subjected, and has been specially designed for economisers. On the centre of the clock-shape dial is a circular metallic paper marked off into sub-divisions, which correspond to those for the gauge pointer on the outer circle of the dial. Attached to the gauge pointer is a pencil which records on the paper the movement of the pointer. The paper requires to be renewed every day, and those taken off can be put away for reference. In cases of continuous testing, and where there is a likelihood of great fluctuations of pressure, the records returned daily to the manager act as a beneficial check and guarantee for the correct pressure being always applied.

The next gauge we notice is one with clock-work for recording variations of pressure. (See fig. 2.)

The clock-work is adopted for the purpose of revolving a drum once in every twelve hours, and by means of a pencil attached to a parallel motion, similar to that on a steam-engine indicator, the various pressures are marked as the drum revolves; thus any differences and the hour at which they take place can be read off.

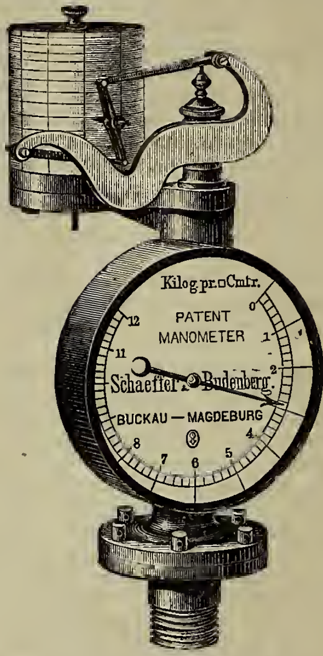


Fig. 2.—Automatic Recording Pressure Gauge.

Another arrangement of gauge is one with an alarm bell attached, and is for both steam and hydraulic purposes; the object being to ring the bell at any given pressure, and so apprise those in charge of a certain pressure having been reached. The apparatus for transferring the movement of the spring to the bell is light and strong, and calculated to ring the bell with great precision.

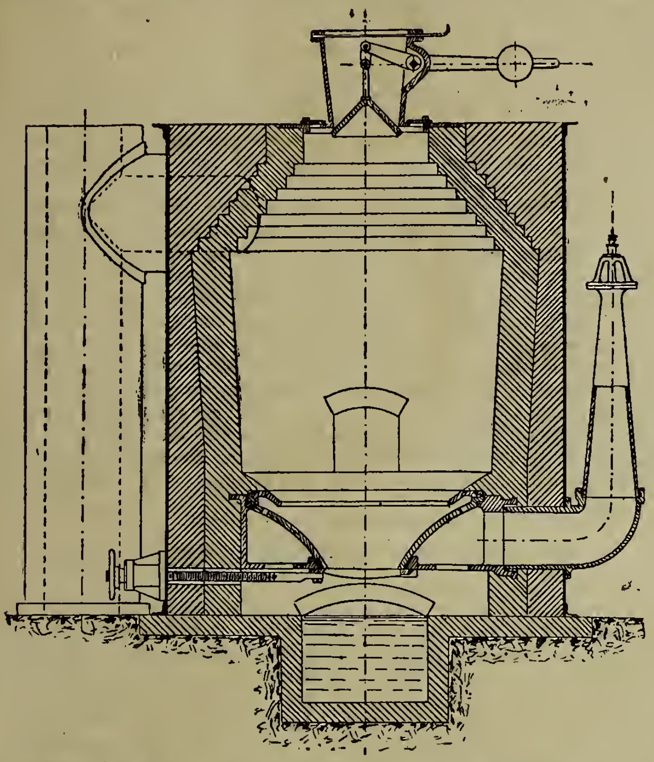
INCREASE IN RAILWAY TRAFFIC RECEIPTS.

The gross receipts of the 23 principal railways in the United Kingdom, for the week ending July 1, amounted, on 15,861½ miles, to £1,298,670, and for the corresponding period of 1887, on 15,746 miles, to £1,239,292, an increase of 115½ miles, or 0·7 per cent, an increase of £59,379, or 4·7 per cent. There was an increase of £8,720 in the London and North-Western Company's earnings; North-Eastern, £7,672; London and South-Western, £6,000; Lancashire and Yorkshire, £5,427; Caledonian, £5,335; Great Eastern, £4,885; North British, £4,294; Great Northern, £4,002; Great Western, £3,830; London and Brighton, £2,175; Manchester and Sheffield, £1,844; Great Southern and Western of Ireland, £1,697; Midland, £1,351; Midland Great Western of Ireland, £1,176; Glasgow and South-Western, £1,003; North Staffordshire, £934; North London, £411; Metropolitan, £350; South-Eastern, £58; and London and Chatham, £39. The aggregate earnings of the following companies for the past half-year show the undermentioned changes: Increases.—Midland, £89,928; North-Eastern, £85,896; London and North-Western, £64,449; Great Western, £37,730; Lancashire and Yorkshire; £32,798; Great Northern, £25,105; Great Eastern, 17,452; London and Brighton, £8,966; North Staffordshire, £7,C02; London and South-Western, £5,943; Midland Great Western of Ireland, £4,797; and North London, £629. Decreases.—Great Northern of Ireland, £1,707; London and Tilbury, £3,534; London and Chatham, £3,588; Great Southern and Western of Ireland, £5,945; and Manchester and Sheffield, £9,175.

SHEEL'S GAS PRODUCER.

Sheel's gas producer, of which we give an illustration, consists of a wrought-iron casing lined with firebrick, and fitted at the bottom with an annular blast box or tuyere, and furnished with a loose grate, which can be withdrawn by means of the hand wheel and screw, as shown, thus allowing the clinkers and ashes to fall into the water trough beneath.

The producer is charged at the top at intervals by means of the bell and hopper, and the interior kept about two-thirds full of fuel. The air for combustion is forced in by means of a steam jet blowing down the taper pipe at the side, and then into the annular tuyere, from whence it escapes into the fuel through a number of small holes round the circumference. To prevent the escape of the blast a lute or trap is made at the bottom of the producer by extending the plates of the wrought-iron shell and allowing them to dip into the water trough. The gas is drawn off from the top under a slight pressure, and carried off through the main at the left hand side in the sketch, from whence it is distributed to the furnaces or other appliances for which the gas may be required.



The producer is made in various sizes. The one shown in our illustration, which has a height of about 9ft. and a diameter of 8ft., is designed to gasify 4 cwt. of coal per hour, and it is stated that a ton of coal will furnish 150,000 cubic feet of gas.

The special feature claimed for the producer is the annular tuyere at the bottom, and the arrangement of the movable grate and water trough, by means of which the attendant can remove the clinker and ashes without interfering in any way with the working of the apparatus, thereby insuring a continuous and uniform flow of the gas.

The producer has been successfully employed in heating iron furnaces, and also for heating steam boilers, and affords perfect control over the temperature as well as over the supply without trouble. The working of the producer can be stopped at any moment, and restarted again almost immediately, even after a stoppage of thirty-six hours, a point of considerable importance.

Proposed Ship Canal from Birmingham to the Mersey.—A large and representative meeting of manufacturers and traders of Birmingham and the Midlands has been held to consider a proposal for a Ship Canal between Birmingham and Liverpool. A scheme was submitted showing that 43 per cent of Birmingham exports went through Liverpool. The estimated cost, taking in the Weaver Navigation Canal, is £1,500,000, and the annual expenditure £138,900, whilst the income, at 4s. per ton on a traffic of 2,000,000 tons would be £400,000, the difference paying 16½ per cent on capital. The principle of the scheme was approved, and a committee appointed to carry it out.

THE ROYAL AGRICULTURAL SOCIETY'S SHOW.

FROM OUR SPECIAL CORRESPONDENT.

The Royal Agricultural Society have been very fortunate this year in the selection of a site for the summer meeting. The beautiful Wollaton Park is a most charming spot, and exceptionally well adapted for the purpose to which it has been put this week. The land is well drained, and even should there fall as much rain as there did last week, it is not likely the ground will work into a puddle, as we have seen it at some shows. It is expected that the forty-ninth meeting of the society will be a most successful one as regards attendance, Nottingham being in such a central situation, and within easy reach of all the great centres of population in the country.

The Machinery Section is the one that concerns us most, and the entries in this department, we are glad to say, are considerably in excess of last year, though they are still below the average of the last fifteen years. We append a table of entries for the last ten years, which will show the comparative importance of the most recent shows.

Year.	Name of Place.	No. of Implements exhibited.	No. of Live Stock exhibited.	No. of Persons. admitted.	Receipts in excess of Expenditure.	Expenditure in excess of Receipts.
					£	£
1879	Kilburn (London)..	11878	2879	187323	—	15000
1880	Carlisle	4196	1485	92011	—	538
1881	Derby	5960	1229	127996	4503	—
1882	Reading	6102	1450	82943	20	—
1883	York	6058	1653	128117	5200	—
1884	Shrewsbury	5241	1664	94126	2300	—
1885	Preston	5313	1563	94192	1921	—
1886	Norwich	4656	1823	194909	—	1062
1887	Newcastle	3616	1825	127372	—	2029
1888	Nottingham	4717	1875	...	—	...

A cursory walk through the implement yard reveals all the old characteristics, and one might almost imagine he was walking through the Preston or the Norwich show over again. A closer survey of the various stands, however, shows that there are, we believe here more than the usual number of novelties; and as an account of these is what will interest our readers most, we shall confine our remarks more particularly to them. In this preliminary notice we shall but briefly touch upon the leading exhibits and principal novelties seen at the show, leaving a more detailed description until another week, when we hope to illustrate several of the new machines.

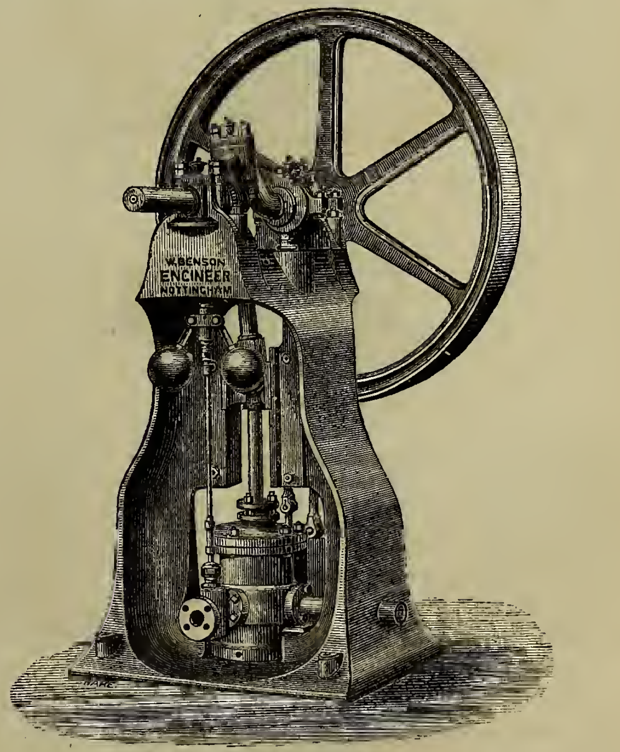


Fig. 1.—Benson's Vertical Engine.

It goes without saying that the well-known firms of Clayton and Shuttleworth, Robey and Co., Marshall and Sons, Davey Paxman, Hornsby and Sons, John Fowler and Co., Aveling and Porter, Richard Garrett and Sons, &c., are well represented at the show with machinery and implements of the very finest description. The reputation of all these firms has been established many years, and possibly they have not thought it worth while, on this account, to introduce any new novelty into their manufactures. Novelties, we know, cost a lot of money, and oftentimes there is very little substantial benefit derived from their introduction, and seldom indeed does it pay to bring out too many of them. Considerations of pounds, shillings, and pence are quite sufficient to deter such firms as we have named, who have no reputation to make, from embarking too much in the novelty line; and hence it is only natural that we should not find much that is new on their stands. The exhibits comprise the old class of machines that have been proved and found to answer their respective purposes with satisfaction, and when we say that the finish is as neat and workmanlike as ever, we have said all that need be for these stalls. Talking of finish reminds us that there are some firms, generally new exhibitors, who have something to learn yet in this direction, as the castings are neither so clean as they might be, nor the general get up so tasteful as one desires or is accustomed to see in the best makers' productions. These people will learn something by comparison with other exhibits, and the experience gained will do them no small amount of good.

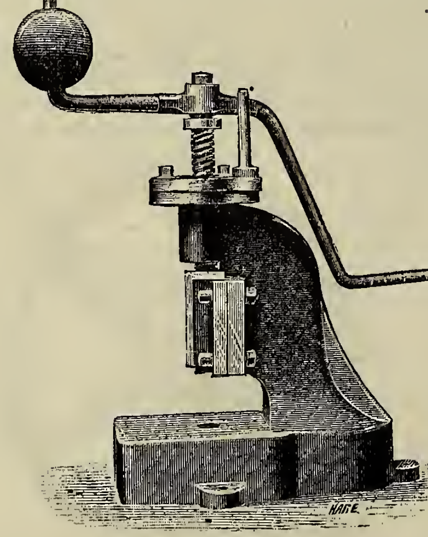


Fig. 2.—Benson's Screw Press,

One new exhibitor, on No. 10 Stand, Mr. William Benson, of Nottingham, certainly does not merit the above strictures, as his show of two steam engines—one vertical and one horizontal—is about as neat and beautiful as any in the ground. The vertical engine, 4 H.P. (see fig. 1), is self-contained in its frame, and is capitally designed throughout. The cylinder is quite central in the frame, and no staying or bracing of any kind is required. The valve rod is straight over its work, and the governor also acts directly on the throttle valve without any bends in the rod. Indeed, the engine is characterised by a directness of action in all the working parts such as is seldom seen in a steam engine. The horizontal engine also has the same characteristic of directness, and the bearings are exceptionally ample. We cannot but compliment Mr. Benson on the creditable and workmanlike manner in which he has turned out these engines. A series of screw presses, by the same maker, one type of which is illustrated in fig. 2, show extreme accuracy of workmanship, and can be relied on for producing absolutely fair forms in the materials pressed out.

A curious compound engine is shown by Messrs. Bradley and Craven, on Stand 217. The cylinders are superposed the one on the other, somewhat after the style of Galloway's engine. The pistons are coupled up to the same crank pin, but instead of travelling together, they travel in exactly opposite directions. This arrangement is effected by means of a pair of levers of the first order, interposed between the piston and connecting rods of the high-pressure cylinder. The arms of the lever on each side of the fulcrum are not of the same length, and consequently the stroke of the piston is much longer than corresponds to the throw of the crank. The net result is that a long stroke and small diameter is obtained in the high-pressure cylinder, and a short stroke and larger diameter in the low-pressure cylinder. The engine exhibited will develop 50 H.P., and has cylinders 6in. and 14in. in diameter, and 21in. and 12in. stroke respectively. There are a large number of working parts introduced by this peculiar arrangement, and it is questionable whether the advantages obtained fully compensate for the extra first cost and additional expense in repairs. The makers, however, claim that the engine is very economical in coal consumption, largely due to the shortness and directness of the passages between the two cylinders, which allows the steam to get on to the long piston without any loss of pressure. Another steam engine out of the ordinary line is shown by Messrs. Wallis and Stevens. The engine is compound, but has only one cylinder. The compound action is obtained by placing a trunk on the underside of the piston, the engine being vertical, of a smaller diameter than the upper side, and the steam enters the bottom end of cylinder first and then exhausts into the upper end. The results obtained from this engine, which is made in various sizes, the one shown being a 2-horse, are said to be very good. The makers claim that an 8-horse engine will work with a consumption of 3lb. of coal per horse per hour. This engine is now exhibited working for the first time, but a cylinder on the same principle was shown at Newcastle last year, and we then took the opportunity of describing it more in detail.

The "Estate" engine shown by Mr. Mather, Wellingborough, is a capital one for the purpose indicated by its name. It has several novel features, notably the method of driving the slide valve by means of a lever attached to the connecting rod. The cylinder is single acting, and the valve is only forced down by the lever and is brought up again by the steam itself. There are two flywheels, which serve also for running on when transporting the engine from place to place; a pair of horse shafts are also supplied. The connecting rod is disconnected when moving the engine, and the piston is held up by a wedge. A circular saw and auger are attached directly to the flywheel shaft, besides the belt pulley for taking off power for any other purpose, and the horse shafts are arranged as supports, to steady the engine when sawing and boring.

A GERMAN ANTARCTIC EXPEDITION.

The exploration of the Antarctic regions is, it appears, to be taken out of our hands and those of Australia. It will be remembered that some time ago a proposal came from Australia that the home Government should contribute £5,000 towards an Antarctic expedition, to which Australia would contribute a like sum. A discouraging reply was returned. It was represented, and rightly, that £10,000 would go a very little way towards the exploration of this enormous area of unknown surface, but that it was the intention of Her Majesty's Government "at a future time" to take up the undertaking, and then Australia would be invited to co-operate. But the few persons in Australia really interested in Antarctic exploration were not satisfied with this, and since then have been casting about to find some means of carrying on the work independently of the mother country. But so far their success has not been great. By the time Her Majesty's Government is ready to consider the subject the work will have been done by Germany, and, as in recent colonial enterprises, our enthusiasm will be kindled when it is too late. It is intended to place in the Prussian estimates a very considerable sum for an Antarctic expedition. A large staff of the best men obtainable will be engaged, naval and scientific, and the organisation of the expedition has been placed in the hands of Dr. Neumayer, of the Hamburg Observatory, who is, perhaps, the greatest authority living on Antarctic matters. It is intended, we understand, that the expedition will stay out until our knowledge of this almost unknown region has been substantially extended. At present it is believed that within the Antartic Circle there must be a very large area of land. We know that there is a long range of high mountains, and at least one great volcanic peak. It will be stipulated that the members of the expedition shall exert themselves to their utmost to explore the region, so that within a very few years we may expect to have another great blank in the globe filled up, and that not by the country of Ross, whose Australian colonies have a practical interest in the physiography of the Antarctic, but by a nation whose interest in the subject is of a purely scientific character. The expedition, we believe, will sail in a few weeks.

Miners' Representatives in Parliament.—As the result of the recent vote on the subject, a Miners' Committee has been formed to inquire into the question of salaries of the Parliamentary representatives of Northumberland miners.

120-TON HYDRAULIC SHEAR-LEGS.*

The shear-legs constructed for the port of Marseilles by the Fives-Lille Company, and placed on the quay near the graving docks, had to be designed to lift a load from a vessel alongside the quay, and deposit it on a wagon or truck near the edge of the quay, for its head to be able to advance 29½ft. beyond the edge of the quay, and to recede 16½ft. behind it, and its height such that the load could be lifted over 23ft. above the quay level. It had to be made to work, at pleasure, at powers of 25, 75, and 120 tons, with a proportionate expenditure of water, and to be provided with a capstan for conveying the loaded trucks directly beneath it, and for removing them. To illustrate the novel arrangements introduced in these shear-legs, the author commences with references to some of the shear-legs previously erected.· The old type consisted of two shear-legs fixed apart, one behind the other, at the bottom, but connected at the top, hanging over the quay to the requisite extent, and maintained in a fixed position by ties anchored in the masonry. The lifting was effected by pulleys fastened to the top of the shear-legs, and moved by hand-winches or capstans; whilst other pulleys were required to draw the load on to the quay. These shear-legs required a number of men, and their greatest power was forty tons. The increased power required for handling the large guns of ironclads and marine boilers has led to the adoption of shear-legs, similarly fixed, but worked by steam or hydraulic power, of which, amongst those made within the last twenty years, may be cited the shear-legs erected at Toulon, Antwerp, Spezia, and Elswick. The machine at Toulon, constructed in 1867, consists of a couple of fixed shear-legs, connected at the top by a strong girder, on which the trolly runs which shifts the load. One steam-winch lifts the load, and another shifts its position. The motive force is an engine of 30 H.P., and the maximum power is 50 tons. The shears erected at Antwerp, in 1878, have three legs, connected at the top by a steel axle; a hydraulic machine, with three cylinders, works alternately a winch carrying a cable for lifting, and two endless screws, which move the bottom of the hinder leg, and, causing the two other legs to turn on two pivots fastened on the quay wall, shift the load horizontally. The working is simple, but the toothed gearing and endless screws produce considerable friction, and are not suited for accelerated working, which is sometimes necessary. The three-legged oscillating shears at the Elswick gun factory transport the load like the Antwerp shears, but the lifting is effected by the aid of a hydraulic cylinder suspended from the shears. The lifting is similarly effected by the shears at the Spezia arsenal, also erected by Sir W. G. Armstrong and Co.; but the horizontal movement is produced by the rotation of the shears. Both these last-named shears can lift 160 tons.

The new shears at Marseilles are three-legged and oscillating, like those of Antwerp and Elswick, and with direct action, both for the lifting and horizontal motion. The piston of a hydraulic press, acting upon the bottom of the hinder leg, effects the oscillating movement; and another hydraulic press, suspended from the top of the shears, accomplishes the lifting. An automatic multiplying apparatus causes the water pressure to be increased for lifting loads of between 75 and 120 tons, and to be reduced for loads of between 75 and 25 tons. An accumulator holds in readiness the greater portion of the water, under pressure, required for one operation. An apparatus, furnished with cables, erected on the back of the hinder leg of the shears, serves for accessory operations, and for lifting loads not exceeding 8 tons. Lastly, a suspended platform, on which the conductor stands, enables supervision to be exercised close at hand over all the operations. The hydraulic cylinder for lifting, instead of being hung from the top, as at Elswick and Spezia, which is liable to cause leakages and thus impair the power of the machine, is suspended from its forged steel bottom by two steel rods, fastened to the top of the shears by a Cardan joint, relieving the cylinder from the strain of the load, and affording it the required mobility. The diameter of the cylinder is 1¾ft., having been calculated for a mean power of 75 tons, with a water pressure of 710lb. per square inch. The automatic multiplier is used for powers of 25 and 120 tons, consisting of two cylinders, placed end to end and fastened together by rods, in which two pistons of different diameters work. Two of these machines, placed side by side and coupled, ensure a continuous motion of the load when lifted. The water pressure, which continues uniform, is directed against the larger or smaller piston, according as the water pressure in the lifting cylinder is to be increased or diminished; for the larger piston, acting on the smaller piston, increases the pressure of the water delivered into the lifting cylinder in proportion to their diameters, namely, up to from 1,280lb. to 1,420lb. on the square inch; whilst, when the smaller piston acts on the larger piston, the pressure is proportionately reduced. The diameter of the large piston is 1·1ft.; of the smaller piston, 10in., and of the connecting rod, 9½in.; and the length of the stroke is 3·28ft. The maximum height of lift, of 46ft., can be acomplished, in case of need, in twenty-eight seconds. The shear-legs were tested, in August, 1887, with a load of 140 tons, and worked perfectly. The efficiency of this machine, with direct action, is much greater than where the power is transmitted by cables, and for loads of 75 to 80 tons, not requiring the intervention of the multiplier, is at least 90 per cent., instead of an efficiency of only 25 per cent for the type of shears like those at Antwerp. L. V. H.

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* Le Génie Civil, vol. xii., 1888, p. 328.

THE NEW TOWER BRIDGE, LONDON.

The following are the leading particulars of the new bridge across the Thames, nearly opposite the Tower of London, and which, when completed, will permit of the passage of sea-going vessels to the Upper Pool.

The bridge, which is being built in accordance with the designs of Mr. John W. Barry, M.Inst.C.E., and the late Sir Horace Jones, is of the "Bascule" type; *i.e.*, the opening portions of the bridge, instead of revolving around a vertical axis, as in most opening bridges, will revolve on a horizontal axis, and will open upwards. The road platform will consist of two leaves meeting in the centre, and will be raised high in the air when the bridge is open for the passage of vessels. There will thus be no interference with the crowded traffic of the pool, which there would be in the case of a bridge revolving around a vertical axis. The bridge will have three spans, the two side spans being fixed, and the central span having traffic ways at two different levels. The lower, or opening one, is that we have just described, the upper one being a fixed bridge for the use of foot passengers when the lower bridge is open for the passage of vessels. The headway of the lower bridge will be 29ft. 6in., and that of the upper bridge 135ft. above Trinity high water, which is more than ample for the masts of ships frequenting the Thames. The headway of the side spans will vary from 20ft. to 27ft. above Trinity high water. The central span will have a width of 200ft. and the two side spans 270ft. each. By way of comparison, we may observe that London Bridge has five elliptical arches, the central one having a span of 152ft., those next it on either side 140ft., and the shore end spans 130ft. each. The headway of the centre arch is 29ft. 6in. at Trinity high water, that of the side arches gradually diminishing towards the ends.

Each of the two piers of the Tower Bridge, which are now gradually rising in the stream, will be 70ft. wide. They are being constructed hollow, with chambers to receive the counterbalanced ends of the opening leaves of the central span. The foundations of the piers are constructed by sinking wrought-iron caissons about 30ft. square 20ft. into the bed of the river. These caissons are filled with Portland cement concrete to a short distance below the level of the river bed, and above that Cornish granite and brickwork in cement are employed. On each of the piers a lofty tower will be erected, the upper part of which will receive the ends of the suspension chains of the side spans, and will also carry the high-level footbridge which spans the central opening. When the lower bridge is open for river traffic foot passengers will ascend to the high-level bridge from one side span, and, having crossed, will descend to the other side span either by means of a staircase or by hydraulic lift, both of which will be provided in each tower. The width of the bridge and its approaches will be 60ft., diminishing to 50ft. at the central span. The gradients of the approaches will be very easy, superior in fact to those of London Bridge, the worst one being 1 in 40. The hydraulic machinery for actuating the lifting portions of the bridge will be supplied by Sir William Armstrong, Mitchell, and Co., of Elswick, and the steam engines for driving this machinery will be placed on the southern side of the river. They will consist of two engines, each of 360 H.P., taking steam from four boilers. Four of the accumulators will be placed upon the piers, and two on shore, upon the south side of the river. The two leaves of the bridge will be actuated by rotary hydraulic engines, acting through gear on four quadrant-racks on the rear ends of the leaves. The chains and girders of the bridge will consume about 7,000 tons of iron and steel; each of the leaves of the bridge will weigh about 350 tons, and the superficial area of each leaf will be about 5,000 square feet. The hydraulic machinery will be of sufficient strength to control the bridge in a wind exercising the extreme pressure of 56lb. per square foot. Although vessels would not dare to quit their moorings with such a gale as this means, the Corporation have undoubtedly exercised a wise discretion in providing for this high pressure, and also in having the whole of the machinery in duplicate in case of derangement of any of the parts.

THE "SUN" ELECTRIC LAMP.

Among the electric miners' safety lamps exhibited on the occasion of the reading of Sir Frederick Abel's paper on mine accidents in November, 1887, before the Institution of Civil Engineers, was the "Sun" lamp, which met with commendation from Sir Frederick Abel. This lamp has been tested by Mr. C. E. Rhodes, who pronounced it to be fully entitled to rank as a miners' "safety" lamp. He, however, suggested some detail improvements which promised to increase the working utility of the lamp, and these improvements have since been introduced into it, and it has now been successfully tested in practical use in two collieries. In the battery of this lamp the positive element is zinc, the negative element being a plate of special metallic alloy. The weight of each negative element is 6oz., and that of each positive element 3oz., the total weight of the elements being 1lb. 2oz., and the total weight of the lamp 4lb. 6oz. The elements are suspended in a depolarising solution of dilute sulphuric acid, and there is no waste going on while the lamp is not running, although the elements remain suspended in the solution. The battery can be used as a primary, but is at its best as a secondary battery, charged from a dynamo in the usual way. The light is emitted from a glow lamp of 1½ candle power nominal, the lamp being protected by a toughened glass cover, and should this be broken the light is instantly extinguished automatically, whether or not the glass of the glow lamp itself be broken, thus giving absolute safety against risk of explosion. The battery is encased in wood and metal, and the lamp is 8in. high by 4in. diameter. The average electromotive force during a period of ten hours is 3·8 volts, the current through the lamp varying from 0·6 to 0·25 ampére, according to the lamp used. The ordinary run of the lamp is ten hours, but Mr. I. Knowles, of the Pearson Knowles Coal and Iron Company, having used it in his collieries, reports that it will run for twelve hours, and he states that he considers it suitable in every respect. The New Portable Electric Lamp and Power Syndicate Company, of 43, Coleman Street London, have also received a highly satisfactory report from the Wigan Coal and Iron Company, who have also used it in their collieries.

THEISEN'S SURFACE EVAPORATION CONDENSER.*

The use of condensers with steam engines is frequently rendered difficult by insufficient supply of condensing water, of which from twenty to twenty-five times the amount of feed-water is required. If it were possible to cool the condensing water quickly, it could be used over and over again. In some cases this is effected by the use of cooling ponds, which, however, occupy considerable space. In Theisen's apparatus the cooling is effected by air-blast from blowing-fans.

The apparatus consists essentially of a plate-metal case, with surface condenser tubes, fixed in the lower half of the case, and immersed in water. The steam to be condensed circulates into these tubes, and the resulting water is pumped out by an air-pump, and finally fed into the boiler by a feed-pump. The condensing water is cooled in the following manner: A number of metal discs, revolving slowly on horizontal spindles, dip partly into the condensing water, and as they revolve carry a small amount of water on their surfaces; a current of air, from two screw-fans fixed at one end of the case containing the condenser, impinges the surfaces of the discs. The cooling action takes place by the evaporation of the moisture on the discs, and as these revolve they take up the heat from the heated condensing water, to be cooled again by the air-current. They are stated to take so much heat from the water as to keep it cool enough for condensing the steam. In Messrs. L. Mannstadt and Co.'s rolling mill at Kalk, near Cologne, the apparatus has been adapted to engines indicating 470 H.P. These engines, it is stated, were formerly worked as non-condensing engines, and the saving by condensing is about £68 monthly in coal, and £8 in chemicals for purifying the feed-water. The article is illustrated by two figures showing the general construction. H. H. P. P.

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* Foreign Abstracts, Proc. Inst. C.E.

CORRESPONDENCE.

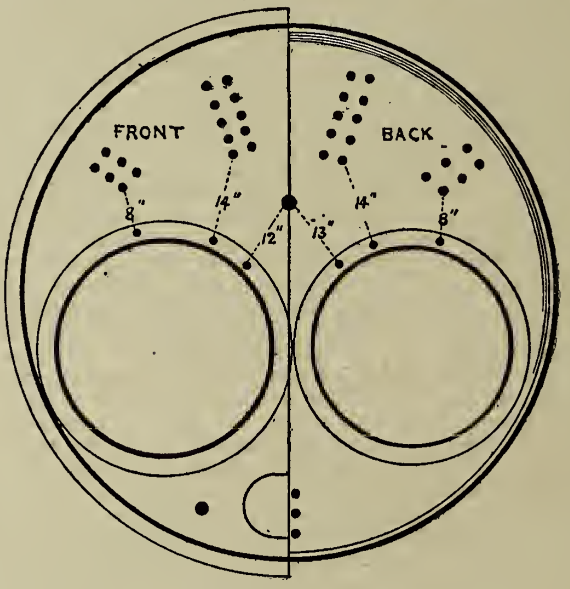
We do not hold ourselves responsible for the opinions of our Correspondents.

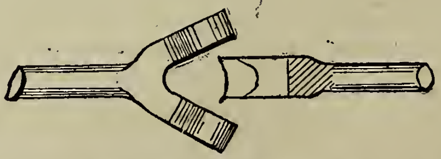
THE GRAYS BOILER EXPLOSION.

To the Editor of "The Practical Engineer."

Sir,—After a lapse of five months, the "Report of the Preliminary Inquiry" has been issued, and to anyone who had the opportunity of seeing the exploded boiler the report must be disappointing in many respects. The explosion was a very remarkable one, inasmuch as the boiler was practically a new one. It was also remarkable, inasmuch as it has exposed to public gaze the loose, slipshod customs and barbarous practices of some people who are probably looked upon as high-class tradespeople, while the report itself is most remarkable in not giving details as to mode of staying ends, strength, &c., of said stays, how they were torn asunder, &c.; for surely if a longitudinal stay is fitted with a forked joint at its mid-length, and after the explosion that forked joint is found sprung open in such a manner as to prove beyond doubt that the pin in the joint was drawn, it should be worth notice.

I do not for one moment doubt the presence of the *hidden fracture*, but I am firmly of opinion the primary rent did not occur there, but at the angle iron rings in flues where connected to back end plate. I enclose you a sketch of back end plate, with the dimensions and positions of gussets, and also a sketch showing section of forked joint. After the explosion the boiler was found to consist of three pieces—the back end, with shell attached (the shell attachment being good); the front end, with left flue and portion of right flue; and back portion of right flue, which had been broken away in its flight. The back end, with shell, shot backwards, while front end, with flues attached, came forward. The stoker, who was in front of open fire, was blown ten yards into an open trench. Now, sir, I maintain the first part to fail was the longitudinal stay by the drawing of the joint pin (this pin was never found). The already defective staying was then unable to support the end plate against the pressure. Hence its failing through the reedy angle iron. The fact of the stoker being blown from boiler front before the actual explosion took place would certainly indicate a rip and escape at back end, which, after extending, would be sufficient to carry firebars, &c., in a forward direction. If the primary rent occurred in the longitudinal seam which unwound so freely, what could have severed the ends from their attachments, particularly the back end? and why were the gussets broken and torn in a manner strongly suggesting their having been under severe tension? Again, had the rent occurred as stated, the boiler would most probably have been carried to the right. With regard to the incompleteness of the report, I will just point out where fuller information might have been given. The boiler is made of single "best," which is known to all practical men to be of too low a quality to be trustworthy for such a purpose as shells for 80lb. pressure, especially when the barbarous method of punching before bending and setting with sledge hammers is resorted to; still, if it were at all doubtful, it remains so, for no attempt was made at testing the plates. The gussets and staying





generally should have merited some notice, seeing that in the solid part of the strongest gusset the section was only 10½in. by ⅜in., and the longitudinal stay was only equal to 1¼in diameter, jointed in the middle, the joint pin probably having no cottar in it. The boiler was quite unrecognisable, having no maker's number. The letter from the makers to Mr. M. Longridge in reply to his inquiry requires no comment, as it may be read several ways, each diametrically opposite to the other. The surveyors express an opinion, long felt all round, that is, that with the present keen competition it is difficult indeed for insurance companies to render that valuable service they are not only capable but desirous of rendering. Taken as a whole, the surveyors seem to have decided either hastily or without considering the whole of the facts and evidence the exploded boiler itself offered. Why did not the fusible plugs melt out when the other furnaces collapsed. This report fully strengthens my opinion that, rather than explain, these reports tend to shroud in mystery the causes of explosions.—Trusting you will excuse so long a letter, I am yours, &c., CHALKLINE.

July 5th, 1888.

[We have pleasure in inserting our correspondent's letter, but as will be seen from the article which appeared in our last week's issue, we differ from him with regard to the cause of the explosion.—ED.]

COMPOUND LOCOMOTIVES.

To the Editor of "The Practical Engineer."

SIR,—As "Practical Observer" has not yet found sufficient time to make reply to "W. B.," and as "W. B.'s" note takes in any class of compounds, I send the following for insertion, if you find it convenient. I have seen many statements regarding the coal consumption of locomotives, both simple and compound, and of these some are to be credited, but others, again, are to be regarded with some slight doubt as to their accuracy. As two instances, I've seen the consumption on the London, Brighton, and South Coast Railway, and also the Great Northern Railway, stated as being 25lb. and 26lb. per mile respectively. I have no information to discredit the case of the London, Brighton, and South Coast engines, but as an offset to the other case I would ask the following question: "How is it that four coupled bogie passenger engines, designed by Mr. Patrick Stirling, who also designed those using only 26lb., use on an average 35lb. to 40lb. per mile?" On the railway where the engines in question are running, the cylinder sizes have been increased within these last few years to 18½in. diameter, and in addition to the consumption of 35lb. to 40lb. per mile, the boilers have been found on several occasions unable to keep up sufficient steam, and as the boilers are as near the utmost limits of size and efficiency as can be applied, this, I think, shows the advantage of compounding.—I am, yours, &c., DREADNOUGHT.

QUERIES AND REPLIES.

COPPER BOILER.—Could any reader inform me what would be the most suitable kind of copper boiler, with fire box, for 2½in. by 3½in. stroke horizontal engine, to be heated by a lamp or otherwise, and what would the dimensions be?—F. W. T.

Answer.—If "F. W. T." will say what speed the engine is to run at, the point of cut-off, and either the power required or the pressure it is desired to work at, also if gas be at hand for heating the boiler, I will try to furnish the particulars he requires.—G.

DRAWING OF A PULLMAN CAR.—Could any reader inform me where I could get a working drawing of a Pullman car and a railway carriage?—E. P. S.

RIVET FURNACE.—Can any reader of your valuable paper give me some idea of an economical rivet-heating furnace for two stationary riveting machines?—P. H.

CONCAVE CIRCULAR SAW.—Can any reader describe the use of a concave circular saw? It is supposed to be attached to the end of saw spindle outside of bench and driving pulleys.—H. C.

MACHINE FOR STAMPING NAILS.—Will one of your readers give me the name of a good firm to manufacture a special press for stamping out nails?—F. C.

THIN PLATES.—Can any of the readers of your practical and valuable paper inform me if it is possible to get thin sheets of iron or steel (say 20's gauge) as large as 8ft. 6in. by 4ft. 6in.? If so, where?—CHALKLINE.

SMOKE-CONSUMING FURNACE.—Can any of your readers give me the address of the makers of Thompson's smoke-consuming furnace?—J. E.

REMOVING BLACK JAPAN FROM STEEL.—Can any kind reader of your paper inform me as to the best way to remove black Japan varnish from steel?—SANDY.

CEMENT FOR INDIARUBBER.—What is the best way to cement rubber to steel?—SANDY.

WORKING DRAWINGS.—Referring to the working drawings which have appeared in your papers, I shall be glad if any of your readers will help me with the following. How is the guide for crosshead fastened to the engine? is it supposed to hang down from the supporting strap by the two top holes? If so, what are the other six holes in each guide for? Ought there to be three more holes in supporting columns for three more supporting straps, as only one is shown in the drawing? Do the transverse distance bars lie across the top of the bearings? also, how are the drag links to be fastened to links, as no place is shown in drawing.—CONSTANT READER.

HYDRAULIC JACK.—Could any of your readers explain, with rough sketch, the action of Tangye's hydraulic jack, as I cannot get to see the inside of one.—DOVER.

GOVERNOR FOR PORTABLE ENGINE.—I have a double-cylinder portable engine by Ransome and Sims driving an electric light plant. There are times when I require it to run 70 revolutions, and others when I wish to run 100 revolutions. Can any reader tell me what sort of governor will suit my purpose? The present one gives a great deal of trouble. Sometimes I put a cone pulley on, but if any reader can give me a better idea I shall be much obliged.—C. H. EGYPT.

HORSE POWER AND ENGINE.—Can any of your numerous readers inform me what is the maximum horse power I ought to be able to get from the following pair of beam engines, working compound and coupled together with cranks at right angles. H.P. cylinder, 16in. diameter; L.P., 32in. diameter; stroke of each, 6ft., running at 36 revolutions per minute, with an initial pressure of 90lb. per square inch on H.P. piston carried on at that pressure to $\frac{4}{10}$ length of stroke. Would one boiler 28ft. long by 7ft. 6in. diameter, working at 95lb. per square inch, be able to supply steam for same, and what quantity of water would be required per day of ten hours for boiler or boilers supplying steam for that power? Any information will be thankfully received by CONSTANT READER.

TO CORRESPONDENTS.

MILL FURNISHING.—In answer to "Tools," the best course undoubtedly is to deal direct with manufacturers. The names will be best found by reference to a trade directory. For a number of brass specialties you might communicate with Mr. J. Bromilow, of William Street Brassworks, Heywood. For makers of other articles look through our advertising columns.

ELECTRIC LIGHTING.—In answer to "Amber," we should have some difficulty in advising you. There are a number of books published on the subject, but it is difficult to say which would be most likely to meet your wants. Your best course would be to write to Messrs. E. and F. Spon, 125, Strand, for a catalogue of their books on the subject, and select for yourself.

BOOK ON PLATING.—The most complete book dealing with the subject which we are acquainted with is Millis's Metal Plate work. The price is nine shillings, and we shall be glad to forward a copy on receipt of postal order for that amount.

CASTING IRON ON BRASS.—As a supplement to the answer to "Snitcher," given in our issue for June 29th, we would refer him to the invention of Mr. Willis regarding the casting of iron and steel on copper, a description of which was given in our last issue under the heading of "Improvement in Propeller Blades."

ENGINEERING BOOKS.—In answer to "Cymro," it is impossible to offer you any advice in the matter until you have decided what special branch you desire to follow. Even then it would be desirable to know your capacities and opportunities. Your best course would be to talk the matter over with someone already engaged in the profession.

TECHNOLOGICAL CERTIFICATE.—"R. T. S." will get full information on applying to the Secretary of the City Guilds of London Technological Institute. Personally, we have not much faith in the preparation for examinations by correspondence. There is no royal road to learning. If a man has brains, and is willing to work, he can teach himself almost anything.

NEMO.—Your question is not very clear. We gather, however, that you wish to know how to cut out the radial plates in the flat, and may say therefore that it is simply a matter of geometry. We cannot afford the space for diagrams to illustrate the whole process in detail, and you had better consult a text book on the subject.

MISCELLANEA.

CHEAP GAS.—The Corporation of Bury have decided to reduce the price of gas to all consumers in the borough to 2s. per 1,000 cubic feet net. The Corporation and their engineer, Mr. W. Woodward, are to be congratulated upon being able to supply gas at a considerably lower price than it is sold at in any other town in Lancashire.

A LARGE CASTING.—The largest casting ever made in the United States, according to report, was cast by the Bethlehem Ironworks, at Bethlehem, Pa., May 10th. It is to be used in building the plant for the new gun steel works. One hundred and twenty-four tons of metal were poured into the mould, and it is believed to have been successful, though several weeks' time will be required for it to cool sufficiently to determine definitely.

THE CUTLERS' COMPANY AND SHEFFIELD TRADE.—Speaking at the Forfeit, or Little Cutlers' Feast, which was held in Sheffield on Friday night last, the Master Cutler (Mr. J. Dixon) alluded to the fact that in the alterations which were now going on at the Cutlers' Hall a stone had been discovered having this inscription, "Cutler's Hall, 1638." He said the Cutlers' Company had for two and a half centuries protected the trade of Sheffield and district; and if the people of Sheffield would only properly support them in the future, and give them credit at all events for good intentions, he believed it would continue to render as great services to the trade of Sheffield as it had done in the past.

PATENTS AMENDMENT BILL.—The Bill to Amend the Patents Act, 1883, introduced on behalf of the Government in the House of Lords by the Earl of Onslow, has been printed. Its principal provision relates to the registration of patent agents. It proposes that after the 1st of July, 1889, no person shall be allowed to describe himself as a patent agent, under a penalty not exceeding £20, unless he is registered under the Board of Trade. Any person who can show that he has been practising for 12 months before the 1st of the present month as a patent agent is entitled to registration. Future registrations will be made under rules to be prepared by the Board of Trade. The other alterations proposed refer for the most part to details of the method of procedure.

Great Western Maritime Ship Canal.—Under this title a canal is proposed to connect the Bristol and English Channels. The promoters contemplate the provision of a new waterway for ocean-going ships of large tonnage from Bridgwater Bay to the estuary of the Exe to connect the South Wales coal and iron districts, the Midland Counties river and canal systems, and the Severn ports with the west and south of England, the metropolis, and the Continent.

A Portable Pneumatic Drilling Machine.—Messrs. De Bergue and Co., of Manchester, who recently successfully introduced into this country the American system of pneumatic riveting, have brought out another useful tool worked by compressed air in the shape of a portable pneumatic drilling machine. They have just delivered one of these new tools, which has a 6ft. gap, and is capable of drilling 2in. holes through steel plates in a very efficient manner. The frame, which is of steel, is of a horse-shoe shape, and being suspended from its centre of gravity in the same way as the riveters, will turn over and drill holes at any angle. Weighing only a little over 6 cwt., this handy tool is really a portable radial drilling machine, which can be suspended by any light tackle, and will drill holes in positions inaccessible to ordinary power drilling machines.

Steel Armour Plate.—The second solid steel armour plate entered for competition against compound plates has just been fired at on board the Nettle at Portsmouth. It was manufactured by Sir John Brown and Co., Sheffield, and was of the specified dimensions of 8ft. by 6ft., and had a thickness of 10in. The attack was from the 6in. breechloader; five rounds at 30ft. with 42lb. charges, two of the projectiles being ordinary Palliser shot, and three Hollzer solid steel shots. The Pallisers were completely broken up. One of the steel projectiles, the first fired, aimed at the bottom right-hand corner of the plate, not only completely penetrated it, but buried itself nearly 2ft. in the bulkhead at the rear, and the second shot, directed at the centre of the plate, just went through the base, being about 10in. from the surface. The third round, as it was fired with greater obliquity, inflicted less damage.

A New Thermostat.—Mr. W. C. Hibbard, Montreal, is manufacturing a thermostat which has recently been thoroughly tested in Montreal, giving the utmost satisfaction. It is a device by means of which alarms are rung automatically in fire-engine houses and wherever else desired immediately upon the occurrence of a fire. It consists of a shallow case, about 1⅞in. in diameter, in which is placed a Bourdon spring, insulated from the case. In the event of fire the spring expands, and when the temperature at which the instrument is set has been reached, the electric circuit is closed and the alarm goes out. The spring being insulated from the case, leaves but a small amount of metal to be heated before the alarm is sounded, thus making the thermostat one of the most sensitive of instruments. Indeed, so perfectly can they be regulated, that they have been known to indicate a fire before a thermometer, but a few feet distant, had registered any change of temperature.

The Imperial Institute.—At a meeting of the Organising Committee of the Imperial Institute held at Marlborough House, the Prince of Wales presiding, Lord Rosebery, Lord Herschell, and Sir John Rose were appointed trustees for the Endowment Fund, the minimum value of which is fixed at £140,000. The Prince of Wales nominated Lord Herschell and Sir John Rose respectively as chairman and vice-chairman of the Organising Committee, and various special committees were appointed. The Organising Section submitted a statement of progress made since the last meeting, by which it appeared that the actual funds now available, exclusive of subscriptions from the Indian Empire and temporarily invested there, amounted to £310,000. The steps taken in furtherance of the establishment of the Department of Commercial Intelligence were described and approved. The tender of Messrs. John Mowlem and Co. for the main buildings, exclusive of the central and eastern and western towers, was accepted from a list of 15 competing contractors, the amount of the tender being £142,800.

The Longitude of Paris.—We understand that the details of arrangement for redetermining the difference of longitude between Paris and Greenwich have been settled between the Astronomer Royal and Mr. Lœwy, of the Bureau des Longitudes and Paris Observatory. It has been decided to use the geodetic station at Montsouris, which has already been connected with several important points in Europe, as the French station and the Royal Observatory as the British. Two English and two French observers will take part in the operations, which will probably commence in September next. In 1854 the work was done by one observer from each observatory, the observations being made by the observer noting the time and estimating the fractions of seconds at which the stars used passed over the wires of the transit instruments and galvanometer needles were deflected. On the present occasion the transits and times of deflection will be registered on chronographs. This work is looked upon as most important by astronomers and geodesists, as it will connect Greenwich with the continental surveys, which have of recent years been made with a very high degree of accuracy.

SELECTED PATENTS.

APPLICATIONS FOR LETTERS PATENT.

June 29th.

9469 Water-heating Apparatus, T. Nixon and T. Buchanan, Glasgow.
9477 Lubricating Composition, W. T. Hicks and J. Elliott, Middlesbro'-on-Tees.
9487 Electrical Instruments, F. L. Rawson and W. White, London.
9494 Manufacture of Explosives, F. J. Beattie, London.
9503 Steam Engines, J. C. Chapman, London.
9504 Steam Engines, J. C. Chapman, London.
9505 Apparatus for Making the Joints of Pipes with Lead, W. R. Geen and G. B. Godfrey, Middlesex.
9507 Apparatus for Forming Man-holes in Metal Plates, P. Mitchell, Finsbury, London.—[Complete Specification.]
9508 Telegraphing Apparatus, W. France and R. Morgan, London.
9509 Sighting Attachment for Small-arms, G. Anderson, Middlesex.
9513 Air Compressing Engine, W. Wilkinson, London.
9514 Torpedo Defence Nets, E. Solomiac, London.—[Complete Specification.]

June 30th.

9517 Machinery for Printing Woven Fabrics, B. Cowperthwaite, Glasgow.
9530 Machinery for Printing Fabrics, J. Wright, Glasgow.
9531 Gas Engines, D. Clerk, Warwickshire.
9533 Filtering Apparatus, H. Gehrke and A. Wohlfahrt, London.—[Complete Specification.]
9535 Incline Lifts for Raising and Lowering Heavy Bodies, G. Newnes, G. C. Marks, and B. Jones, Birmingham.
9537 Lubricators, E. Baldwin, Leicestershire.
9540 Centrifugal Machines, C. Steffen and C. J. Langen, of the firm of F. Langen and Hundhausen, London.—[Complete Specification.]
9547 Electric Motors, R. R. Hutchinson, London.
9548 Apparatus for Distilling Water, and for Feeding Boilers, C. Howe and J. H. Beckwith, London.—[Complete Specification.]
9549 Refrigerators, A. J. Boult, Middlesex. (J. Bustin, France.)
9553 Adjustable Electrical Lighting Devices, A. L. Fyfe and J. Main, Middlesex.
9554 Apparatus for Interlocking Points on Railways, W. Holland the younger, and W. T. Page, London.
9555 Distribution of Hydrocarbon Oils for Illuminating Purposes, T. Hawley, London.
9561 Construction of Ships, A. Greig and A. C. Franklin, London.
9562 Casting Metal, M. Scott, London.

July 2nd.

9568 Hoist, J. Taylor and Sons, Nottingham.
9578 Gas Engines, J. Dougill, Manchester.
9581 Hydraulic Vices, L. L. Pendred, London.
9583 Metallic Packing-plates for Pistons of Vibrating Engines, H. J. Allison, London. (W. E. Crist and T. Hawkins, United States.)—[Complete Specification.]
9584 Galvanic Batteries, S. Miller, London.
9586 Apparatus for Carburetting Gas, J. Thomas, London.
9587 Utilising Tidal Power, F. Wade, London.
9588 Electrical Appliances for Lighting Trains, F. G. Oberdorfer and J. Neu, London.
9590 Stamp Mills for Crushing Ore, J. J. Tregoning, London.
9595 Electro-motors, W. H. Allen and R. Wright, London.
9596 Rotary Engines, A. J. Boult, Middlesex. (J. H. Venables, J. Hughes, and S. Coxon, Canada.)
9602 Motor Engines, C. D. Abel, London. (The Gas Motoren Fabrik Deutz, Germany.)
9603 Apparatus for Excavating Water Courses, A. Languet, London.—[Complete Specification.]
9609 Locomotives, C. W. Hullings and J. S. Valentine, London.
9610 Compound Engines, J. J. Prins, London.—[Complete Specification.]
9615 Incandescent Electric Lamps, G. H. Rayner, Middlesex. (J. Ragonet, Paris.)

July 3rd.

9618 Coupling Gear for Buffer Trucks, W. Hill and J. Hill, Dover.
9620 Nails, E. Hodded and E. V. Cooke, Salford.
9631 Coupling Railway Rolling Stock, R. Graham, Carlisle.
9632 Mineral-oil Lamps, E. J. Shaw, Walsall.
9638 Apparatus for Supplying Fuel to Furnaces, J. Proctor, Manchester.
9641 Pulley Blocks, A. Higginson, Liverpool.
9652 Generating Steam from Molten Slag, H. H. Lake, London. (O. B. Peck, United States.)—[Complete Specification.]
9659 Lubricating Axles, T. Colquhoun and J. A. Thompson, London.
9660 Electric Motors, A. J. Boult, Middlesex. (O. Lugo, United States.)—[Complete Specification.]
9661 Telephone Transmitters, A. J. Boult, Middlesex. (J. Emmner, jun., United States.)—[Complete Specification.]
9662 Type-writers, A. J. Boult, Middlesex. (J. F. McLaughlin, United States.)—[Complete Specification.]
9664 Machines for Rolling Metal Articles, A. J. Boult, Middlesex. (C. F. Tebbetts, United States.)—[Complete Specification.]
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July 4th.

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EDITORIAL NOTICES.

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Communications intended for insertion in the current week's issue should reach us not later than Tuesday Evening.

We cannot undertake to return rejected manuscripts or drawings unless accompanied by a stamped and directed envelope.

Contributors are requested to write on one side only of the paper. Sketches should be sent on separate sheets.

TO ADVERTISERS.

Advertisements intended for insertion in the current issue should reach us on Wednesday morning at the latest.

THE
PRACTICAL ENGINEER.
JULY 20TH, 1888.

LIMITED LIABILITY AND BANKRUPTCY LAW.

THE question of amending and improving the present state of the law regarding the formation and constitution of limited liability companies, as well as proceedings in liquidation and bankruptcy, formed the subject of discussion at a conference held on the 11th inst., at the rooms of the Society of Arts, London, and composed of representatives of chambers of commerce throughout the country, as well as of several members of Parliament interested in the matter.

Although there is little chance of the bill which proposes to deal with the subject, and which in fact formed the basis of discussion at the meeting, passing this session, yet there is little doubt the question will very shortly have to be dealt with, while the subject affects every class of trade so widely, that the proceedings of the conference and the expression of the views of the various speakers deserve particular attention.

In a memorandum drawn up by the association, and laid before the meeting, and in which the clauses of the bill at present before the House of Lords were examined, it was urged that the assimilation of the procedure in liquidation to that in bankruptcy would result in greater speed and economy in the distribution of estates, as well as the exposure of fraud and irregularities on the part of trustees; while Board of Trade supervision by combining under one department all matters relating to insolvency would strengthen those provisions of the law intended to safeguard the interests of honest traders, and promote commercial morality throughout the kingdom. Referring to the present bill, the association regretted that it only proposed to deal with the amendment of the Companies Act, 1862, seeing that the law relating to the subject of limited liability is embodied in a number of Acts of Parliament and an enormous number of legal decisions.

The Chairman (Colonel E. S. Hill, M.P.) rather leaned to the opinion that it might be well, perhaps, to accept the Lord Chancellor's bill, which dealt chiefly with the inception of limited companies, as an instalment of legislation on the subject, leaving the questions of consolidation and liquidation to be dealt with at another opportunity. Mr. Chamberlain, M.P., however, did not agree with these quasi-favourable opinions, as he considered the bill a bad one, both in respect of what it did and what it did not do. Limited liability, he thought, was very largely responsible for the bad condition of trade which had prevailed for so many years, and which was not so much depression, in the ordinary sense of the word, as over-production, very largely stimulated by the creation of bogus companies. From the principle of limited liability we could not go back, and what had to be done was to see if the evils which had attended its working could not be remedied. There were, he thought, three points to which, in any legislation on the subject, attention should be directed. The first and most important was to prevent fraud and misrepresentation; the second was to increase the responsibility of directors and promoters; and the third was to provide for the economical and equitable distribution of the assets of those companies which came to grief. Alluding to the present bill, he thought the clause dealing with the disclosure of any consideration paid in the establishment of the company was a good one, and calculated to secure the object in view. But the clauses which provided that one-fourth of the whole nominal capital must be subscribed, and not less than one-tenth paid up, he considered quite impracticable. The difficulty in limitative proposals lay in the fact that companies varied so much in their objects and methods; and while there might be no reason whatever why a large proportion of the capital should not be paid up in one case, such as a manufacturing establishment, there might be the very strongest objections against the adoption of such a course in connection with a bank or financial undertaking, where the uncalled capital practically constituted the security to the company's clients. The clause providing for the issue of a report by the liquidator of a company, although framed with a good object, was, he considered, worthless, because it contained no provision, in the case of an incorrect report, for any department to call for an amended report; and as the liquidator was, under existing circumstances, appointed by the solicitors to the parties, it could not be expected that a fair account of fraud or mismanagement would be forthcoming under such circumstances. Another clause to which there was great objection was that which stipulated that one-fifth of the capital should be held by the directors. This, in the case of companies whose capital was measured by millions—such as Guinness's, for instance—it would be impossible to comply with. The clause which made it obligatory on the part of a director to pay up all his shares in full was also unworkable in the case of companies whose called-up capital was only a small fraction of the nominal, and would place the director at a great disadvantage as compared with the ordinary shareholder, and deter anyone from accepting the position. Adverting to the absence of any provision in the present bill for effecting an improvement in liquidation proceedings, Mr. Chamberlain considered this the most important defect in the present law, the evils of which, as stated in the circular forwarded to members of the conference, arose from undue delay, want of control on the part of creditors and shareholders, cost of procedure, want of publicity, and the fact that there was no inquiry into the causes of failure and conduct of officials.

That the law regulating the formation and working of joint-stock companies is badly in need of amendment will, as we stated a few weeks ago in referring to the matter, be denied by very few persons who are at all familiar with the gross frauds that are palmed off upon the public under the guise of limited liability companies; and personally we cannot but regret that some legislative measure dealing with the subject will not be passed during the present session, and on the principle that half a loaf is better than none, we should have been glad to see the Lord Chancellor's bill dealing with the inception of companies converted into an Act, even though it deals only with a portion of a large subject. Most of the defects in the clauses of the bill referred to at the meeting were such as could have been readily amended in committee, and the Act would at least have served as an instalment of much-needed legislation, even if the question of liquidation of companies had been allowed to stand over.

We quite agree with the views of Mr. Chamberlain regarding the damaging effect upon trade produced by the floating of bogus companies, or, for the matter of that, by the wholesale floating of genuine companies; and there can be no doubt that the present severity of competition in several industries is largely attributable to this cause.

That the present state of the law with regard to the liquidation of insolvent companies is an anomaly, and loudly calls for reform, is undoubted. There is not the slightest reason why the law should not provide for the winding-up of insolvent limited companies in local courts of bankruptcy just in the same way as private firms, and the enactment of such a law would put an end to much of the rascality that now prevails in connection with the interment of defunct limited liability companies which, so to speak, ought never to have been born.

THE MANCHESTER SHIP CANAL.

The vigour and enterprise with which the work in connection with the canal between Liverpool and Manchester is being pushed forward is in striking contrast to the Ribble Navigation fiasco. To complete the canal within the four years specified in the contract it will be necessary to excavate the material at the rate of about one million cubic yards per month. During the six months the work has been in operation the contractor has exceeded this amount, the excavation for the month of May amounting to upwards of 1,030,000 cubic yards. It is difficult for persons unaccustomed to deal with figures to realise what a million means, and a graphic idea of the monthly excavation may be formed if we say that it would suffice to fill a hole 300ft. square and 300ft. deep. The extent of the operations now in progress may be gathered from the fact that there are at present in active employment upon the works 56 steam excavators, 73 locomotives, 2,367 wagons, 50 steam cranes, 79 miles of temporary railway, and 6,000 men. It is estimated that the undertaking will be completed by the end of 1891, when a waterway twice the width of the Suez Canal and of equal depth will be in active operation.

THE RIBBLE NAVIGATION SCHEME: THE WORKS STOPPED; THE CORPORATION CENSURED.

Some rather startling evidence was given before the Select Committee of the House of Commons appointed to consider the Preston Corporation Bill, at its sitting on the 12th inst. Up to this point the evidence laid before the committee had been all in favour of the scheme, and its advocates appeared to have established a very good case. But the old adage, that "one tale is good until another is told," probably never received a more apt illustration, for when the witnesses on behalf of the opposing ratepayers were called the case for the Corporation's scheme, which had been so elaborately built up, collapsed like a pack of cards. The most damaging witness against the scheme was Mr. Walker, the contractor who was engaged to carry it out, and who attended to give evidence on the order of the Speaker. A letter which the witness had addressed to the Corporation a few days before was read, in which he expressed surprise at the evidence laid by the Corporation before the committee, and took grave exception to the erroneous impression which had been conveyed with regard to his opinion of the scheme. Over and over again, he said, during the past two years he had strongly urged the Corporation to call in some eminent engineer accustomed to dock and river work, and more than six months ago offered to suspend the dock works to enable the Corporation to complete the dredging and remodel the scheme, should they desire. In answer to further questions, the witness said it would cost about £5,000 per annum to maintain the works in their present condition if progress were arrested, and that he advised the Corporation to call in an eminent engineer to report on the scheme so long ago as October, 1886.

In addition to Mr. Walker, several other witnesses gave evidence to the effect that the action of the Corporation in carrying out the scheme had been of the most rash and ill-considered character. Mr. Simpson, chairman of the Ratepayers' Association, said that out of 47 cotton firms in the town 31 belonged to the association opposing the scheme. Mr. Thomas Coulthard, a magistrate and employer of labour, gave some interesting particulars with regard to the public debt of the borough, from which it appeared that in 1887 the total debt was £1,393,000, representing £4 4s. 3d. per pound of rateable value, and £12 13s. 4d. per head of the population. Adding the cost of the works (£650,000) and the cost of the navigable channel (£300,000), the debt would be £2,343,000, representing £6 13s. 3d. per pound of rateable value and £21 10s. 9d. per head of population. Further evidence was called which disclosed a deplorable state of affairs, and one calculated to fill the minds of Preston ratepayers with consternation and alarm.

In giving their decision, the Chairman of the Committee said they felt that the conduct of the Corporation was deserving of the severest censure, and that there was nothing either in the financial or commercial aspect of Preston in the year 1884 to justify them in embarking on the extended scheme. Further, the committee stated that, in their opinion, the opposition of the ratepayers and the course they had adopted were fully justified by the evidence laid before them. With a view to enable the Corporation to reconsider their position, and come before Parliament next year with a full and complete scheme, the committee made certain financial arrangements with a view to the suspension of the present works, and expressed a hope that all the conflicting parties would meet together in order to extricate the community of Preston from what threatened to be a very serious financial embarrassment.

It will be seen that the endeavours of the Corporation of Preston to become the possessors of docks of its own have placed that unfortunate town in a most unenviable position, and the monument to its pride which it is already reputed to possess in the form of a "church without a steeple," appears likely to be shortly supplemented with another to its folly, in the shape of a dock without a channel.

THE ENGINE AND BOILER INSURANCE COMPANY.

The report of the chief engineer of the above company for the year 1887, a copy of which we have received, fully sustains the reputation that Mr. Michael Longridge has established for himself as an authority on everything connected with the working of steam engines and boilers, and forms a striking comment on those who seek to disparage the good work that is being performed by boiler insurance companies. The report, which occupies one hundred folio pages, is brimful of interesting and scientific information, specially valuable to steam users. From a table giving the details of the various breakdowns of engines enrolled with the company during the past year, it appears that 21 per cent arose from the negligence of the owners or attendants; 39 per cent from causes purely accidental or unascertained; 31 per cent from weakness or faulty design; while 9 per cent were due to old defects or ordinary wear. With a view to reduce the number of accidents due to negligence, Mr. Longridge makes the sensible recommendation that every owner should personally inspect his engine once a week, say on Fridays, and see that every bolt, cotter, and pin is tight, and every brass well up, and if anything is faulty to see that it is attended to on the following Saturday afternoon. There can be no doubt that as far as engine breakdowns are concerned the proverbial stitch in time would very often save a great many nines, and it is not too much to ask that engine owners should, in regard to inspections, reciprocate the efforts of the insurance company. Indeed, apart from the questions of breakdowns and insurance, the systematic and periodical visits of the owner to the engine-house is to be commended on moral grounds as productive of good feeling and mutual respect between a steam user and one of his most responsible servants.

Turning to an analysis of the accidents to insured engines, showing the parts which probably failed in the first instance and thus caused the breakdown, it appears from a list of 114 breakdowns which occurred during last year, that broken valve gear heads the list, not only for that period, but for the whole time during which a record has been kept. Referring to the probable explanation of this, Mr. Longridge states that when makers give up cutting deep V threads upon reduced diameters, and when millowners refuse to accept valve spindles so designed, especially if they are made of steel, the records of failures of valve gears will occupy a much lower position on the list.

Next to failure of valve gears as the cause of breakdowns comes the failure of spur gearing, and in connection with this question Mr. Longridge gives a careful mathematical analysis of the principles which should govern the formation of wheel teeth. Referring to the breakdowns that occurred, it may be well to give Mr. Longridge's own words. He states that, "although last year the company was fortunate, it generally has much trouble and loss with the breakages of the teeth of heavy gearing. There are a number of cases where the damage is the result of inequalities of pitch, of twisted teeth, of unequal bearing through the settlement of foundation or wear of brasses, and by backlash caused by large rope drums on the second motion shafts; but, besides all these, a number of wheels made as perfect as moulding machinery and mechanical skill can make them, and carefully attended to, yet come to grief, owing, in a great measure, to the excessive length of the teeth. Of late years the length has been gradually reduced in consequence of a general increase in the speed and pitch; but still the teeth are far too long. The fact is virtually admitted by all wheel makers, for the centres and radii of the circles used by them for describing the flanks and faces of the teeth are so chosen that both the roots and points of the teeth lie far inside the cycloidal curves these circular arcs nominally replace. The actual teeth are finer both at the roots and points than the cycloidal teeth they are meant to represent. The consequence is, that when the wheels are new the teeth touch each other, or 'bear on,' only for a short distance on each side of the pitch line; gradually, however, the bearing or bright band creeps up towards the points. The last are ground away, while the flanks below the pitch line are scooped out, and the pitch line becomes a well-defined sharp ridge across the tooth. This wear goes on at an ever-increasing rate, till finally, unless chipping be resorted to, the tooth breaks off."

Referring to the defunct Boiler Registry and Inspection Bill, and the Blue Book recently issued by the Board of Trade with regard to the same (to which reference was made in our issue of June 8th, *page 265 ante*), Mr. Longridge compares the whole document "to the evidence for the prosecution *before it has been sifted by cross-examination*, rather than a judicial summary of the facts affecting the matter at issue, as proved by each side." It will be seen, therefore, that Mr. Longridge practically confirms the views already expressed in these columns with regard to the Blue Book in question. Like him, we cannot but regret that a Government document should have been made the medium for the dissemination of statements which, to say the least of them, are very misleading.

In the course of his report, Mr. Longridge discusses at considerable length the question of the strength of cylindrical furnace and flue tubes, but want of space forbids us dealing with the report at greater length on the present occasion, and we defer a reference to this, as well as to the results of several interesting evaporative tests of steam boilers, to another opportunity.

MACHINERY FOR THE STEELWORKS AT TERNI.—II.

(Continued from page 329.)

STEAM HAMMER.

The great hammer occupies the central part of a large octagonal building, covering under one roof the hammer, its attendant cranes, and the four Siemens furnaces used for heating the large ingots. The cranes are carried on trucks running on a circular railway laid on the floor of the building, and their jibs swing round a central pivot placed on the top of the hammer frame.

The distinctive feature of the Terni hammer, as compared with others of about equal power in existence on the continent, lies in the use of wrought iron for the frame instead of cast iron, as used in the Creusot and St. Chamond hammers. A stronger and more elastic frame is thus obtained, less liable to suffer from heavy blows and vibration, and allowing of the full power of the hammer being more freely used. This frame is raised upon a large bed of masonry, in which a chamber is reserved for the lodgment of the anvil block. The masonry foundation reaches a depth below the soil of nearly 32ft.; its upper surface consists of a layer of hewn stone 3ft. 3in. in thickness, on which are laid two very heavy bed-plates of cast iron 2ft. in height, cast with a thickness of metal of about 4in., and weighing each about 40 tons. Each bed-plate is held down by eight large rolled iron bolts, square in section, measuring 7in. on the side, placed one at each angle of the pillars of the frame. The upper ends of these bolts have a screw thread turned on them, and are held by large nuts; the lower ends are let down to a depth of 20ft. into the masonry, and are secured by cotters resting against a cast-iron plate 5in. in thickness.

To counteract the vibrations due to the fall of the hammer, and the tendency to spread of the inclined pillars or legs of the frame, the two bed-plates are strongly bound together by two horizontal cross-ties passing through them and held on both sides by large screw nuts. These ties are of forged steel, their minimum diameter is 8in., and for greater facility of manufacture and erection each one is made in three parts, the joints consisting of dowels and cotters. The frame itself consists of four large pillars or legs, inclined outwards towards the base, and built up of sheets and angles riveted together. The legs occupy in plan the corners of a rectangle measuring 36ft. in length by 20ft. in width. Between the legs there is an open space of 27ft. in width on the long sides of the rectangle, and of 11ft. 6in. on the shorter ones. Thus there is ample room for handling the largest ingots.

At a height of 40ft. from the ground the four pillars are connected by an entablature, consisting of a wrought-iron box girder made of sufficient strength to carry the whole weight of the cylinder, piston rod, and hammer head, amounting to a total weight of nearly 150 tons. Above this entablature the pillars are continued to a height of 65ft. above the ground, where they unite and form a kind of vault over the cylinder, crowned by the central pivot around which the cranes revolve.

It was proposed by the makers to use a double-acting cylinder, which would have largely increased the power of the hammer. The authorities at Terni seem, however, to have entertained fears that the violence of a double-acting hammer might have proved destructive to the surrounding buildings and machinery, besides which a 100-ton dead-weight hammer was considered a sufficiently powerful forging instrument for even the largest class of work.

The cylinder is consequently single-acting, and of a diameter of 6ft. 3½in., the stroke being 16ft. 5in. It is cast in two parts, of nearly equal height, united by bolts passing through thick flanges.

In supporting the cylinder it was sought to obtain the greatest possible stability, and to reduce the height within reasonable limits. With this view the cylinder is fastened to the large cross-girder by means of a thick flange, cast with the lower half of the cylinder, and made rectangular in plan, so as to carry the weight directly on the vertical webs of the girder, which are specially stiffened to receive it. This flange is placed at about 5ft. from the base of the cylinder, and is strengthened by stout vertical ribs cast on the lower half thereof. The cylinder being thus held at an intermediate point of its length, and having its lower end embedded in the ironwork of the frame, may be expected to have much greater rigidity during work than if merely bolted down by one end in the usual style.

The piston is of cast steel, cup-shaped, with two ordinary cast-iron packing rings. It is attached to the piston rod by a conical end and a nut. The piston rod is of forged steel, 14in. in diameter. Care has been taken to avoid unnecessary rigidity in the connection between the hammer head and the piston rod. The lower end of the rod is forged with a cylindrical swelling, terminating in two spherical segments above and below. The lower of these two segments fits somewhat loosely into a steel cup resting on the bottom of the cavity in the hammer head, and protecting it against the immediate contact of the piston-rod head when falling. A somewhat similar cup, but made in two parts, is placed over the swell of the rod, and each half cup is held in its place by a strong cotter passing completely through the hammer head.

The guides are of cast steel, bolted on to side standards built up of plates and angles. Their cross-section shows a large projection occupying about one-half the breadth, which fits into a corresponding groove hollowed out in the sides of the hammer head. When not in use, or when tups are being replaced, or repairs done, the hammer head is held up by means of two large sliding bolts running through the guide bars, and which can be worked backwards or forwards by means of a hand lever.

The hammer is worked by means of two ordinary balanced valves, one for admitting the air to the cylinder and one for the exhaust. Certain arrangements have been introduced into the construction of the valves, so as to allow of their being easily worked by means of hand levers. The valves have flat seats, and their contact surfaces have been reduced as far as possible by rounding the edges of the valves, so as virtually to become mere lines or circumferences of contact. In this manner the pressure on both sides of the valves is nearly equalised, and only a slight effort is required to raise them from their seats. As, however, the effect of wear may be expected to increase the contact surfaces after a certain length of time, the working levers have been so disposed as to exert their greatest power at the moment of raising the valve from its seat. Once lifted from its seat, the valve offers no other resistance than that due to its own weight, as the pressure of the air is equally balanced on both sides. The lever then acts with a continually increasing arm, and the ascent of the valve becomes more and more rapid until it reaches the positions corresponding to the full admission.

Both inlet and exhaust valves are worked in exactly the same manner and by the same lever. The hand lever, which works in a sector, is in its mean position when both valves are closed, and by putting it backwards or forwards one or the other of the two valves can be opened. One man can work the hammer without effort, and under ordinary circumstances two blows can be given per minute.

Certain precautions have been taken in case of accidents, such as, for instance, breakage of the piston rod, or the inertia of the piston causing it to overrun its course. The top cover of the cylinder is of light sheet iron, so as to offer but little resistance, and immediately above it, fastened on to the frame, are two large balks of timber, destined to act as buffers in case any part of the cylinder or piston should be projected against the frame. Two similar balks are bolted under the girder carrying the cylinder. During ordinary work the piston is prevented from rising too high by means of holes pierced through the upper part of the cylinder, by which the air can escape when the piston has passed their level.

The hammer head is of cast iron, and weighs 100 tons; its lower face is grooved so as to receive a cast-steel tup held in position by wedges, and easy to remove.

The anvil block consists of a single casting, of the great weight of over 1,000 tons, cast in one piece. This block has the form of a truncated pyramid, 13ft. square at the top, increasing to 19·7ft. × 24ft. at the bottom, surmounted by a rectangular table 10ft. square and 1ft. 8in. in height. This block was cast *in situ*. Of the metal required, some 600 tons were brought from the foundry in a molten condition, being transported by rail on ladles a distance of nearly 1¾ miles. The mould was broken up four months after the cast, when the heat was still too great to allow of any work being done in the casting pit, and at the end of six months the surface of the block was still warm. This casting is believed to be the largest ever made. The surface was found to be sufficiently clean and straight to render planing unnecessary for placing the anvil, and the metal was proved by borings to be in a thoroughly sound condition throughout the whole mass of the block.

LESSONS IN MECHANICAL DRAWING.—XIX.

By Prof. A. MacLay, B.Sc., C.E.

LOCI—POINT PATHS *(continued)*.

Ex. 91, Figs. 101 and 102.—A point moves uniformly about and at a constant distance from another point, which is itself in motion. To draw the curve showing its path. Take two simple examples—(*a*) When the primary point moves in a straight line; (*b*) when it moves in a curve, *e.g.*, an arc of a circle.

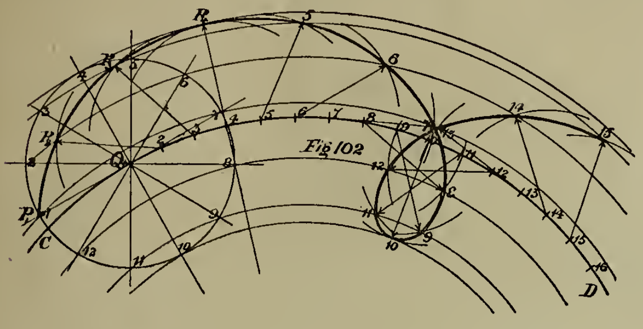
(*a*) In fig. 101 (see last lesson, p. 307), the point P moves about the primary point Q uniformly, and at a constant distance of 1½in. from it, while Q moves uniformly along the straight line CD at the rate of 6½in. per revolution of P round Q.

Construction: Draw the line CD as the path of Q, and mark off on it a distance $Q_1$13 of 6½in. With Q_1 the first position of Q as centre, describe a circle of 1½in. radius, and divide its circumference into say twelve equal parts, and draw parallels to the line CD through the points of division. Then divide the length $Q_1$13 into the same number of equal parts. The points of division will mark successive positions of the point Q. With centre Q_1 and radius 1½in., cut line CD at P_1 for the beginning of the curve; with centre 2 on line CD, and same radius cut the first parallel above CD at point 2 on the curve; from centre 3 on CD, cut the second parallel to find point 3 on the curve. In this way, from centres 4 to 13 find the remaining points 4 to 13 by cutting the parallels as the successive positions of P_1, and through them draw the trochoidal curve as shown in the figure. In fig. 101 the continuation of the curve is shown until it again passes through the highest point.

(*b*) In fig. 102 the point P moves uniformly about the primary point Q and at a constant distance of 1¼in. from it, while Q moves uniformly along an arc of a circle of 4¼in. radius at the rate of 5½in. per revolution of P round Q.

Construction: Draw CD an arc of a circle of 4¼in. radius, and beginning with point Q_1, step off a distance $Q_1$13 of 5½in. round the arc CD in short distances, say of ¼in. at a time.

With Q_1 as centre, radius 1¼in., describe a circle, find twelve equidistant points on its circumference, and through these draw circles concentric with the arc CD. Divide the distance $Q_1$13 into twelve equal parts. (To do this, first divide $Q_1$13 into four equal parts by re-bisection, then divide one fourth part into three, by trial with the small spring dividers.) These points will mark successive positions of Q, and the corresponding positions of P are obtained by cutting the concentric arcs with a constant radius from these centres, as shown by the numbers on the arc CD, also on the circle whose centre is Q_1 and on the path of the point P in fig. 102. Lastly, through the points so found draw the curve which is the path of the point P.

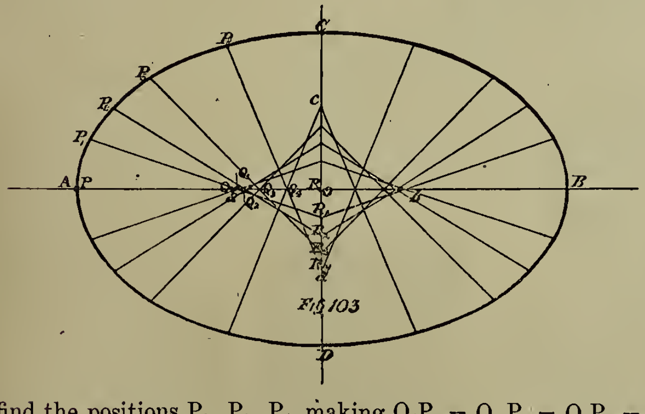


Ex. 92, Figs. 103, 104, and 105.—To show the path of a point on a line, when the extremities of the line are constrained to move in different paths. For simplicity let the describing point be the middle point of the line.

(*a*) Fig. 103.—Both extremities moving in straight lines, the one in a direction at right angles to the other.

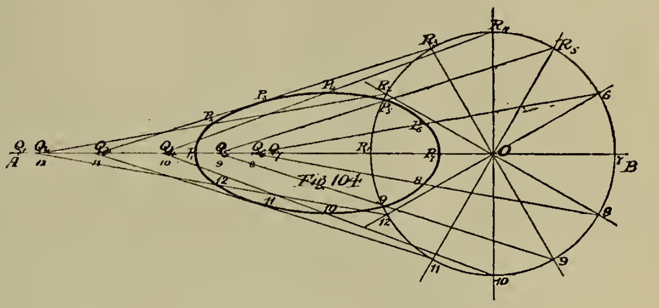
In fig. 103 QR is the line, and P is a point on the line produced. While Q moves along AB and R along CD, P describes the elliptic path ACBD.

Construction: Draw two lines, AB and CD, at right angles to one another, meeting at O. Along OA measure O*a* = RQ, say 1in., and *a*A = QP, say 1½in. A is the first position of P. Let R move down OD to position R_1, Q will come into position Q_1 on AO. Draw a line through R_1Q_1 and produce it towards Q_1, making Q_1P_1 = QP. Similarly, find the positions P_2, P_3, P_4, making $Q_4P_4 = Q_3P_3 = Q_2P_2 = Q_1P_1$ = QP. When R is at *d*, Q is at O, and P is at C; thus CO = PQ. Q now moves along OB, and R returns along DO, while P traces out CB, the second quadrant of the ellipse. When P reaches B, Q is at *b*, and R has returned to O. R now begins to move along OC, while Q returns to O, while P traces out the arc BD. Lastly, while R comes back along CO to O, and Q returns along OA to its original position at *a*, P traces out the remainder of the ellipse and completes the figure ACBD. It will be observed that PQ + QR = OA = OB, the semi-major axes of the ellipse, and that PQ = OC = OD, the semi-minor axes. When these are given then, this is one of the methods used for drawing an ellipse, and in the form of the elliptic trammel fig. 103A, is often so employed. In fig. 103A grooved cross arms CA of hard wood or metal give the necessary constrained axial motion to pins Q and R on the cylindrical bar PQR. The relative positions of the sliding pieces P, Q, and R can be altered at pleasure to give different sizes or shapes of figures. When the adjustable sliding piece at P, for example, is shifted out to P^1, Q and R remaining as set for the inner curve, the outer ellipse is described. This, it will be observed, is not a parallel ellipse, but differs both in shape and size.



(*b*) Fig. 104.—When the one extremity moves in a straight line, the other in a circle.

In fig. 104, Q has a reciprocating straight line motion and R has a motion in a circle. Let the line be 4½ft. long and the stroke or range of motion be say 3ft. Draw to a scale of $\frac{1}{12}$ the path of a point P situated midway between Q and R



Construction: Draw a line AB, and at a point O on it as centre, and radius 1ft. 6in., describe a circle and divide its circumference into twelve equal parts. Beginning with point R_1 on the circle as centre, and with radius 4½ft., cut the line AB at Q_1. Then from R_2 on the circle with the same radius cut the line at point Q_2. In the same way find the remaining points 3 to 12 on the straight line, and join R_1 Q_1, R_2 Q_2, &c., and bisect each line so drawn to obtain twelve points on the elliptic path of P, as shown by the curve P_1, P_2, P_3, &c., in the figure.

SAND-DRIFTS ON THE CENTRAL ASIAN RAILWAY.

It is stated that the Russian engineers on the new line in Central Asia have been much troubled with sand-drifts blocking the line. From Merv to the crossing of the Amu-Daria the line runs across a plateau which is peculiarly exposed to high winds, and where the soil is light and sandy, with very little vegetation. After many experiments, they have settled on the use of a native bush called *saksaoul*, which grows rapidly, sometimes to a height of 15 or 20 feet, and sends its roots down very deep into the sand. A plantation of this bush along the line not only covers and consolidates the soil on which it grows, but also interposes an effectual barrier to the drifting of sand from the bare plains beyond. The *saksaoul* bushes are being planted all along the line, and strict orders have been issued against cutting them down either in the new plantations or in those already existing. Other methods have been tried, but this seems the most promising. Much trouble from the same cause was experienced on the Southern Pacific line across the Yuma Desert in Southern California. The sand-drifts were much worse to handle than snow-drifts, for the reason that sand packs down hard where it drifts and cannot be handled by a snow-plough, the shovel being the only resort. On the Southern Pacific the only effectual preventive has been to encourage the growth of vegetation wherever possible, and the Russians seem to have reached the same conclusion.

The Products of a Ton of Coal.—A ton of coal yields about 8,000 cubic feet of gas and 1,500 pounds of coke. The purification of the gas furnishes 45 gallons of ammonia water, from which is obtained sulphate of ammonia for agricultural purposes, and about 130lb. of tar. It is here that the operation becomes especially interesting, for from this last-named product are obtained 70lb. of pitch, 18lb. of creosote, 9lb. of naphtha, 13lb. of heavy oils, 6lb. of naphthaline, 4lb. of naphol, 2lb. of alizarine, about 1lb. each of phenol, aurine, and aniline, 10oz. of toluidine, 6oz. of anthracene, and 12oz. of toluene. Finally, it will interest photographers to know that hydroquinon, that product that has been so much spoken of recently, and which was at first obtained from cinchona, is now obtained from coal by industrial processes.

THE ROYAL AGRICULTURAL SOCIETY'S SHOW.

FROM OUR SPECIAL CORRESPONDENT.

[*Continued from page 332.*]

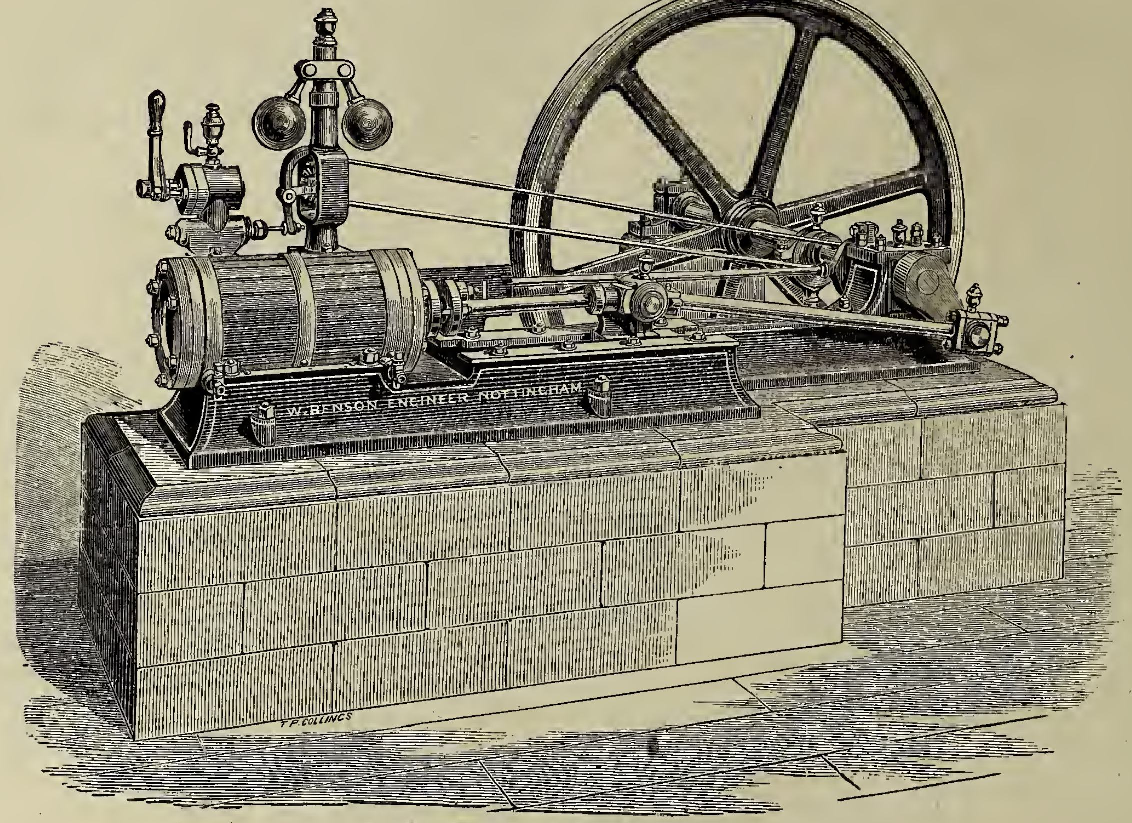


Fig. 1.—BENSON'S HORIZONTAL ENGINE.

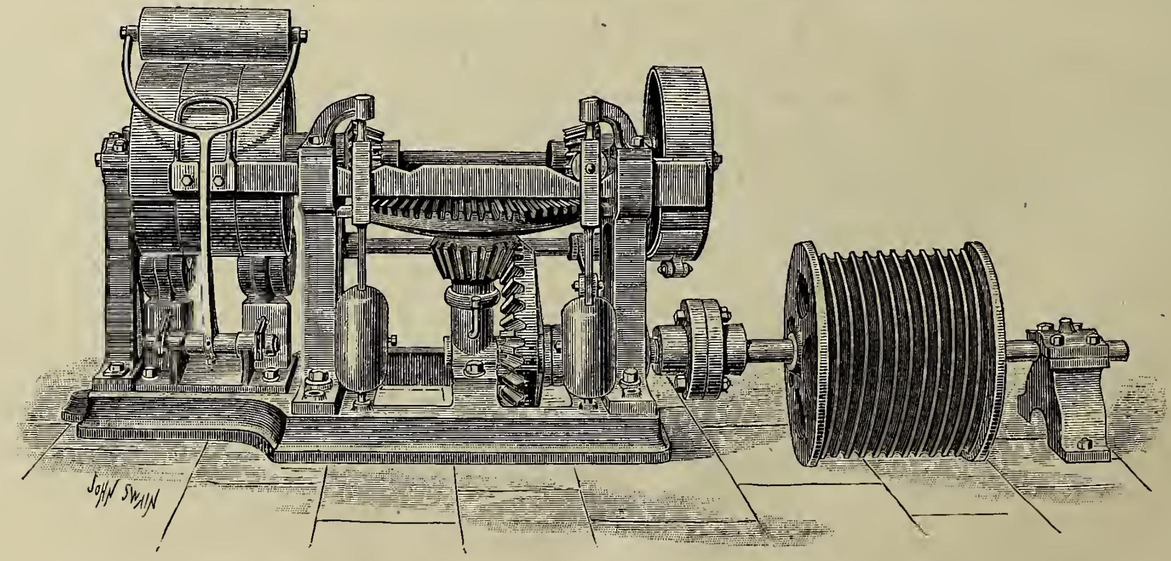


Fig. 2.—TAYLOR AND SONS' PATENT SAFETY HOIST.

Before proceeding to a notice of other exhibits, attention may be called to the illustration of the small horizontal engine by Mr. William Benson, of Nottingham, to which reference was made in our last week's issue. The engine, it will be seen, has a broader crank-shaft bearing than is common with small engines of this character. The brasses in this bearing are fitted in four parts, and possess a neat and substantial arrangement for taking up the wear, consisting of a double screw, the outer one of which sets up the wedge, while the inner one serves to lock it fast. The bed is nicely shaped, and the crank-shaft bearing is cast on it. A very good feature in the engine is the neat way in which the valve rod connections have been managed. It will be apparent, of course, that the valve rod and eccentric rod are not directly opposite each other, and it is necessary therefore to set back from one to the other. In this engine the eccentric rod is pinned to a slide set on its edge, which works in a bracket fixed to the bed, while the valve rod is attached to a pin on the opposite side of the slide. The necessary set off is thus obtained, and a nice-looking job is the result, while the thrust on the valve spindle is absolutely straight, no twist being possible with a broad slide bearing of this description. The governor acts through a short bell crank on the equilibrium valve, and is very sensitive. The engine is very open and convenient, and everything about it is finished in the best style.

Amongst the small motors we noticed the petroleum engine of Messrs. Priestman Bros., of which we give an illustration in fig. 3. The firm exhibit three sizes of their motors—1, 4, and 8 horse respectively. The great advantage of this engine is that it will consume oil of very high flashing power, and so avoids the risk of dangerous explosions. At the Trinity House common petroleum, flashing at 150°, is used in these engines, and the safety is therefore all that can be desired. On account of this extreme safety no extra premiums are charged on buildings for insurance where these engines are used, and the makers use this as a strong argument in favour of their engines. It might be thought that the cylinder would become coated with carbon very soon, considering that the oil is actually burnt in the cylinder, and that very frequent cleaning would be absolutely necessary; but we are told that an engine will run three months without cleaning, and, in a report by Sir William Thomson, it is said that carbon was not formed on the cylinder sides. The cost of working compares favourably with gas at 3s. 6d. to 4s. a thousand feet, which is about the average price in this country, so that even in gas districts the engine may compete with the ordinary gas engine, and in districts where gas cannot be obtained this type should command considerable favour. The lighting of the charge is effected by an electric spark, and the system has been reduced to the greatest simplicity, and can be managed by the least educated farm labourer.

In contrast to the above engine, where the oil is drawn into the working cylinder itself, there is shown, attached to one of the "Stockport" gas engines, a small apparatus for vaporising benzoline, the vapour being afterwards used in the cylinder precisely in the same way as ordinary gas. The vaporiser is a patent by Mr. Hearson, 235, Regent Street, London, and from the experiences of the apparatus that Messrs. Andrew and Co. have already had, they anticipate for it a very remarkable success. The apparatus is very small, and can be attached to any gas engine of the Stockport type in a very short time, and without disturbing anything but the gas connections. The benzoline flows down to the vaporiser from the tank in which it is kept, and is there evaporated on coming in contact with a hot tube kept heated by a small flame burning round it. This flame is supplied by gas from the vaporiser itself when in operation, and only requires starting in the first instance by lighting a small quantity of methylated spirit placed in the dish when the engine is required to begin work. The evaporation ceases immediately there is sufficient pressure in the tube to balance the liquid pressure of the benzoline in the tank, and therefore the oil is only drawn on as the engine demands—neither faster nor slower. An adjusting shield is supplied for varying the proportion of gas and air according to the work on the engine for the time being, and the whole apparatus is finished in a style that reflects the greatest credit on the inventor. We shall probably return to this ingenious apparatus, and describe it, with drawings, in a future number.

There are no new specialties worth mentioning in the gas engines, with the exception of a new tube igniter that is now attached to the "Stockport" engines. The "Griffin" engine, recently described in this journal, is exhibited by Messrs. Dick, Kerr, and Co. Coming to general machinery, we may mention a hay pressing, trussing, and weighing machine, combined. The parts are very compact, and well and strongly made. The pressing lid is counterbalanced, and rises in a sloping direction, so as to clear the head of the operator. The first handle will put on a total pressure of 1½ tons, and the final lever for closing up will put on 9 tons. Messrs. Bradley and Craven exhibit a new brick-making machine, with internal gear, the merit of which is that it can be converted into a hand machine very readily by simply raising the small driving wheel out of gear and putting hand sprockets into the large driving wheel and using it as a hand wheel.

We were somewhat surprised to see a large Lancashire boiler in the showground, but Messrs. Cowen, a local firm, are exhibiting one 20ft. long by 6ft. 6in. diameter. There are four cross pipes in each flue, the latter being 30in. diameter. The ends are ½in. thick, and the usual full complement of fittings are attached. A test pressure of 120lb. was applied after construction.

Messrs. John Fowler and Co., Limited, Leeds, showed an 8-horse traction engine, provided with two speeds of travelling on the road, which can be changed immediately from one to the other. A winding drum is also provided for hauling the engine out of difficult places, or for hauling heavy loads up inclines when the engine itself cannot draw them. The chief novelty about the engine was the hind road wheels, which were fitted with springs of a new type. In this wheel the springs really form the spokes of the wheel, being coupled to the tire and to a central box on the driving axle. The driving strain is transmitted by means of an arm, firmly secured to the central box and coupled to the tire by links and pins and buffer springs, which take off all jerks at starting. In this way the radial springs are relieved from all driving strain, and only carry the weight of the engine. A five-furrow balanced plough for steam ploughing was also exhibited, the implement having been improved recently in the draught rope attachments. Besides the manufacture of purely agricultural machines, this well-known firm does considerable trade in electrical apparatus, wires, &c., and they showed on their stand a new form of wire for telegraph, telephone, and electric lighting purposes, which they are introducing into this country from America. The wire is Tatham's patent, and consists in covering the cable—the individual wires of which have, of course, been previously insulated—with lead. The lead is put on hot, with hydraulic pressure, and any length of cable can be made by the process. The wire is quite flexible, and very durable, and the insulation obtained is perfect. Samples of the patent cable were shown, cut from lines that are now working in Cincinnati and other places in the States. One cable contained as many as 110 telephone wires.

Mr. Isaac Hill, Derby, showed an improved saw-sharpening machine. In this machine an emery wheel is carried by the short arm of a lever, the long arm of which is connected to the crank on the revolving spur wheel, as shown. By this means the emery wheel is raised for the passage of the saw teeth. The long arm just mentioned is really a flat steel spring, and its flexibility prevents too much pressure being put on the teeth whilst sharpening, and so avoids "blueing" or softening of the saw, which otherwise results. The emery wheel will top the saw as well

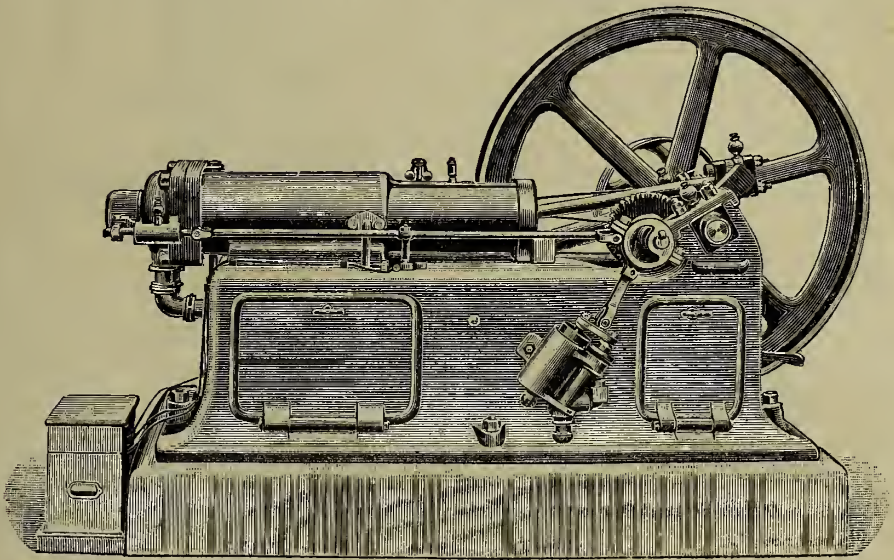


Fig. 3.—PRIESTMAN'S PETROLEUM ENGINE.

as sharpen the teeth, giving that trueness of periphery so essential for correct and good work with cold-iron circular saws. This machine is well and strongly made, and is suitable for taking in saws from 6in. to 24in. diameter; a larger size will take saws from 12in. to 36in. On the same stand was also shown a very useful machine for cold sawing, fitted with three speeds of self-acting feed, varying from 1⅛in. to ½in. travel per minute. The tool which is shown by our engraving will cut solids up to 3in. thick, and girders, Z sections, &c., up to 12in. by 5in. The saw is quite flush on the working side, being stiffened sufficiently by a boss on the machine side. The bolt heads are let into the saw flush with the surface, and hence the saw is enabled to get close up to its work, and is very suitable for cutting off risers and other similar work.

Messrs. Bennett and Sayer, engineers, Derby, exhibited their special plastic contractor's brick plant at work. The capacity of these machines is 30,000 three-inch wire-cut bricks per day of ten hours. The plant consists of a wet pan for grinding and mixing the clay, a duplex elevator for conveying the clay from underneath the pan to the top of the grinding rollers, a brick machine with roller grinding mill attached, and a cutting-off table and steam press.

Messrs. John Taylor and Sons, engineers, Queen's Road, Nottingham, exhibited a patent safety power hoist (see fig. 3). It is provided with two safety appliances—one for holding the cage when the rope breaks, and the other when the driving belt gives way. Both are of the roller and inclined plane system. In case the rope breaks, the inclined planes, situated at each corner of the cage, are pushed up, and an indiarubber roller in each box, coming in contact with the cage slides, is rolled up the plane until it is wedged tight, and brings the cage to rest. The second safety appliance is situated under each driving pulley, and consists of two circular jaws of the same contour as the pulleys, but coming closer at one end than the other. Each jaw contains an indiarubber roller, which, in the normal condition, is quite free of the pulley. A long fork, carrying a wooden roller at its upper end, and hinged at the lower end, constantly leans against the working belt on the inside, and is really held up in position by the belt. Should the latter break, the fork drops down and draws out a couple of wedges which have been holding down the jaws previously mentioned; these jaws now jump up, freed by a spring underneath each, the rollers touch the pulley, and are by the movement carried at once to the thin end of the opening, where they scotch fast and securely lock the whole of the mechanism. We saw the apparatus tried several times, with a large weight on the cage, and were convinced of the great certainty of its action. Irrespective of the safety appliances, the hoist is a well-made and exceedingly compact piece of mechanism, combining simplicity with great power and accessibility of all working parts.

Messrs. Smith, Bros., and Co., Hyson Green, Nottingham, had a good collection of steam pressure and vacuum gauges, and a variety of steam fittings suited for every branch of the engineering trade, including injectors, sight-feed lubricators, asbestos packed cocks and valves, tube expanders, &c., &c. It is worth while mentioning that this firm are the original inventors of the steam-pressure gauge. A specialty on the stand was an elevator for raising water by steam pressure to almost any height.

The society this year had offered prizes for four classes of hay and straw presses, and numerous exhibitors entered implements for the competitions. The prizes and winners were as follow:—Class 1.—For a hay and straw press, worked by steam power, 1st prize, £30, John H. Ladd and Co., London; 2nd prize, £20, Samuelson and Co., Banbury. Class 2.—For a hay and straw press worked by horse power, 1st prize, £20, Geo. Stephenson, Newark; 2nd prize, £10, John H. Ladd and Co., London. Class 3.—For a hay and straw press worked by hand power, 1st prize, £20, Joseph Bamber, Preston; 2nd prize, £10, William Warnes, King's Lynn. Class 4.—For a press for old hay worked by hand power, prize £20, John Bamber, Preston. The competition amongst the hand presses was very one-sided, Mr. Bamber's machine, being nothing but a simple screw press, winning very easily. In the other classes there was much more even competition, but there is no doubt that the best machines won. The above concludes our notices of some of the chief novelties in what must be considered an exceptionally good show.

IMPORTATION OF MACHINERY INTO ITALY.—With a view to promoting the textile industry of the country, the Italian Government is about to introduce a bill for the purpose of removing the import duty on machinery introduced into Italy for the manufacture of tissues and embroidery.

THE GLASGOW EXHIBITION.

FROM OUR SPECIAL CORRESPONDENT.

(*Continued from page 330*).

THOMPSON'S patent indicator (fig. 3) is another of Messrs. Schaeffer and Budenberg's specialties to which attention should be called, as there are several novel features in its construction. It is claimed that the taking to pieces and the putting together again of the instrument is more simple than in the case of the Richards' indicator, while a small size of the instrument has been designed with a special view to the indication of engines running at high speed. The link motion which carries the pencil is as light as possible, thereby eliminating the irregularities in the diagram caused by the inertia of the moving parts, while the piston is rigidly attached to the rod to avoid unnecessary friction through the tilting of the piston. The tension of the helical spring, which effects the return movement of the paper drum, can be lessened or increased as required, thus allowing the user to regulate the tension of the cord to suit the speed of the engine. The instrument, it may be stated, is entirely adopted by the German navy.

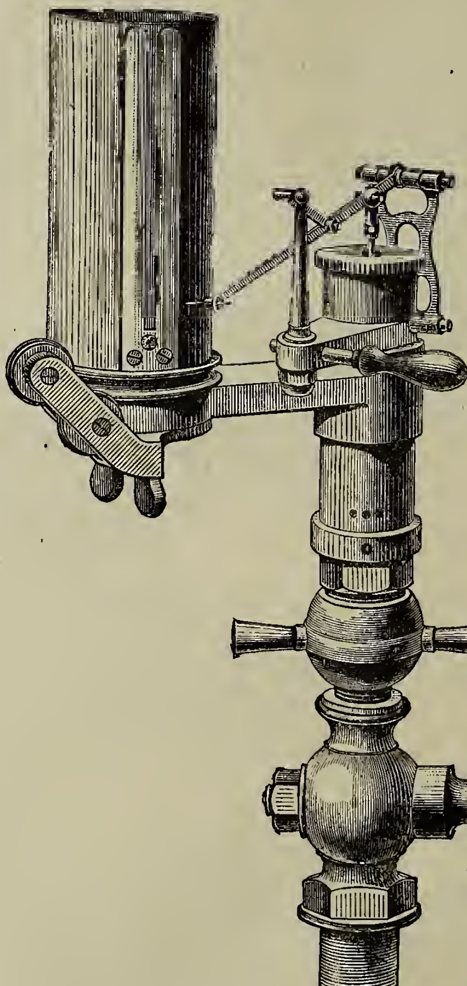


FIG. 3.—Thompson's Patent Indicator

The ordinary size of indicator is suitable for taking diagrams of engines running upwards of 400 revolutions, while the small indicator is specially designed for speeds as high as 600 revolutions per minute, and is found to give excellent diagrams at the highest engine speeds attained in practice, without the necessity of taking special precautions of any kind.

The perfect restarting injector made by this firm (fig. 4) also deserves a word of notice. The injector works either lifting or non-lifting, and feeds the water at a temperature of 140° F., and even higher, and will work without loss of water with a steam pressure varying from 35lb. to 160lb. on the square inch. The manipulation of this injector is exceedingly simple, and when once properly started continues to work without interruption.

Before closing our notice of this exhibit, mention may be made of Flörings' patent packing rings, of which the firm are the sole agents, for the purpose of packing the joints of steam pipes, manholes, &c. These packing rings, which rejoice in the distinctive name of "Melallographite," consist of a coil of very fine steel wire, combined with a fireproof composition. They are inserted between the joints and tightened up in the ordinary way. It is claimed for the packing that it is cheaper and more durable than indiarubber.

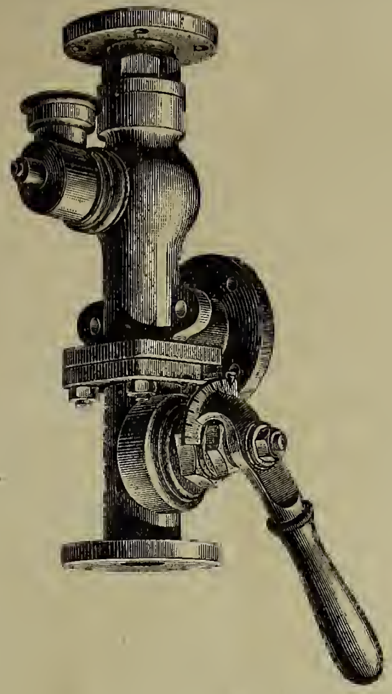


Fig. 4. Self-starting Injector.

PECULIARITIES OF ALLOYS.

Alloys formed by melting two or more metals together present some very interesting characteristics. One of the most curious is the fact that the melting point of the alloy is usually much lower than that of any of its components. Wood's alloy, for instance, which consists of lead, tin, cadmium and bismuth, melts at about 150° F.; whilst the lowest melting point of any of the metals separately is that of tin, 446°. It has always been supposed that this alloy could only be formed at a comparatively high temperature; but Mr. William Hallock has recently shown that when the separate metals are mixed together in filings, and exposed for twenty-four hours to the heat of an ordinary water-bath (212°), the alloy is produced and the mass becomes fluid, and that the previous fusion of either constituent is unnecessary. This fact is of the highest scientific importance, and it is rather remarkable that it has never been observed before.

Professor Roberts-Austen lately read a paper at the Royal Institution on "Some Curious Properties of Metals and Alloys," in which he alluded to the fact that a body, whether called simple or compound, might have the same chemical composition, and yet possess very different physical properties. This is notably the case in organic compounds. Chemists have adopted the word "isomorism" and the phrase "allotropic condition" to recognise this fact, which, however, is as yet without explanation. The belief is that it is the molecular grouping of the chemical atoms that is different. In metals combined together there appear to be many unexplained anomalies. A mixture of tin and arsenic cannot be distinguished from ordinary zinc. Tin, as manufactured, behaves differently under different temperatures, some military buttons made of this metal having crumbled to dust in the cold at St. Petersburg. Aluminium does not suffer much from oxidation, nor does mercury, yet an alloy of the two does. Bismuth, tin, and lead may be mixed without much change of temperature, but the addition of mercury brings the mixture to freezing point. The presence of foreign bodies or impurities in metals frequently affects their strength or tenacity. This fact was well illustrated by the lecturer with bars of pure gold, and bars of gold mixed with 2·10 per cent of lead. The pure gold stood a pressure of from 16 to 17 tons per square inch, while the alloy gave way at an almost nominal pressure. The study of this subject is not one solely of theoretic interest; it has its practical aspects, though these have been rather overlooked too long. One of the results of such study is that the copper used for telegraphing is now made in an entirely different manner to what it used to be, and the advantage gained is increased conductivity. It would have been impossible to pass the number of messages over the old wires that are now sent by means of the improved machines.

WHEEL LOADS OF AMERICAN LOCOMOTIVES.

Among the new eight-wheel locomotives made during the last few years (says the *National Car Builder*) there has been noticeable a constant tendency toward larger sizes and increased total weight placed on the driving wheels. A great deal of injury has been done to tires and rails in the past through the slipping of drivers caused by the weight provided for inducing adhesion being too small for the power exerted by the cylinders; and we have been constant and consistent advocates of better proportions, so that the co-efficient for adhesion between tires and rails might be maintained high enough to prevent slipping on dry or sanded rails. It is gratifying to find that in most instances locomotive designers now provide much better proportions than were common a few years ago; but there are now indications of danger in a new direction. The weight that can be safely placed on two pairs of driving wheels must have a limit, and when the aggregate is so great that about 20,000lb. press the metal of each tire into the steel of the rail, we think the limit of safety must be reached; and close examination of the steel rails where engines having this enormous weight on the drivers are running indicates that the limit of economy has been passed.

Ten years ago the engineers of many railroads used their influence to prevent more than 10,000lb. being placed on one wheel, and even with that comparatively light weight the indications were that the locomotive caused the greater portion of the wear to the rails. Mr. O. Chanute investigated this subject very carefully some years ago, and he found that with the light weights then in vogue the pressure of the drivers on the limited point where the tire and rail meet approximated closely to the ultimate crushing resistance of the metal. He concluded that from one-half to three-fourths of the rail wear was due to the pressure of the engine wheels alone. European engineers experimenting in the same direction reached conclusions substantially the same in regard to the wear of rails on the lines they were connected with. Complaints about the rapid wear of steel rails are already highly pronounced on many roads, and the present tendency is to put the blame upon the manufacturer. The prevalence of cold flow of metal on the surface of the rails, and of numerous crushed rail ends on the divisions where locomotives with excessive weight on the drivers are at work, may soon direct attention in another direction.

The tendency constantly is to place increasing burdens upon the locomotive. The cars are every year built heavier, and the locomotive must pull the same number or more, and make faster time with the trains. Then the boiler has to supply steam for compressing air to operate brakes and signals, and those in charge of the mechanical departments perceive that their engines must soon be able to provide steam for heating the cars and for driving dynamos to generate electricity for lighting purposes. This being the case, there is strong temptation to design locomotives with boilers so large that the weight on two pairs of drivers is too great for the rails. The question then arises, why not use three pairs of driving wheels, and by that means make a better distribution of the weight? A few roads have tried mogul or ten-wheel engines for passenger service, and we see no reason why the practice should not be widely extended; yet there is a widespread antipathy to placing a locomotive with more than two pairs of drivers in front of a passenger train. Men will say that it is not safe to have the heavy rods required for six coupled engines flying up and down at the velocity required for a fast-running train; but no one will give particulars of the breakage of rods belonging to that class of engine caused by fast running, for accidents of the kind are scarcely known. The rods and running gear of a six-coupled locomotive may be a little harder to maintain on fast passenger service than the same parts of an eight-wheel engine, but the difference is not sufficient to count against the former type of engines being employed on the work named. Where it is necessary to use fifty-ton locomotives for passenger service, we are satisfied (says our contemporary) that it will be found more economical to place the adhesive weight on three pairs of driving wheels than on two pairs. If the engine is specially designed for fast running, with large wheels, long steam ports, ample bearings, and well-proportioned rods, the cost of maintenance will be no more than in the case of over-weighted eight-wheel locomotives.

EXPERIMENTS WITH 480 H.P. TURBINES AT OLCHING.*

The installation consists of two turbines, one of the Jonval and the other of the Girard type, with vertical axes enclosed in wooden chambers. The latter were originally made for a smaller quantity of water, but to avoid costly alterations it was decided to construct the two motors, with which the trials were carried out, to suit existing arrangements. Under ordinary circumstances, for about nine months out of the year, the quantity of water available is from 565 to 600 cubic feet per second; in dry seasons this is reduced to from 350 to 390 cubic feet, and in very extreme cases, which, however, only last a short time, to 250 cubic feet. The fall is 9ft. 6in., and invariable.

The two turbines are so designed that with the normal quantity of water both work together with full admission. When the supply of water diminishes, the Girard wheel, which is the smaller, is regulated by closing some of the guide passages. The manufacturer, Mr. J. G. Landes, of Munich, guaranteed the following results:—

(1) With both wheels working at full power with the normal quantity of water an efficiency of 75 per cent.

(2) With the Jonval wheel full, and the water admitted to two-thirds of the passages of the Girard wheel, 74·6 per cent.

(3) With the Jonval wheel full, and admission to one-third of the Girard wheel, 73·8 per cent.

(4) With the Jonval wheel alone 75 per cent.

The Jonval turbine was designed to develop at least 300 H.P. under all circumstances, and the other motor to utilise the remaining energy. The following are the leading dimensions of the two wheels:—

Jonval Turbine.

Angle of outflow from guide passages	18° 50′
,, ,, ,, wheel buckets	16° 37′
Mean diameter of wheel	11ft. 1·86in.
Width of buckets	2ft. 7·7in.

The wheel is divided by a partition into two concentric parts of unequal width; for the outer of these the number of guide vanes is thirty, the number of wheel buckets thirty-eight; for the inner portion the corresponding numbers are respectively twenty-three and twenty-nine.

Girard Turbine.

Angle of outflow from guide passages	24°
,, ,, ,, wheel buckets......	36°
Mean diameter of wheel	9ft. 6·38in.
Width of buckets at top	0ft. 11·81in.
,, ,, ,, bottom	2ft. 5·14in.

For measuring the effective power of the motors a Prony brake was employed, the brake wheel having a diameter of 7ft. 2·61in. The only available place for the application of the brake was on the horizontal first-motion shaft, driven by bevel gearing from the vertical turbine shafts, and it was therefore necessary to allow by calculation for the friction of the gearing and horizontal shaft to arrive at the power actually developed; in doing this a coefficient of friction of 0·07 for the bearings, and 0·13 for the bevel gearing, was allowed.

The quantity of water used was measured by means of current meters in the head race, the total section of the channel being divided into twenty-eight rectangles, in each of which the velocity of flow was observed. As a check upon the accuracy of the results, three instruments by different makers were used simultaneously.

Owing to the absence of a weir in the tail race, by which the level of the water could be regulated, the Girard wheel had to work partly immersed, and the Jonval wheel (3·86in.) clear of the tail water, and the efficiency of both turbines was thereby somewhat reduced.

The following are the results of the trials:—

No. of Trial.	Mean Number of Revolutions per minute.	Effective H.P.	Head of Water.		Quantity of Water used per Second.	Available HP.	Efficiency.	Remarks.
			Ft.	Ins.	Cubic Feet.		Per cent	
1	69·0	472·24	9	3·7	595·86	629·35	75·0	Both turbines together.
2	70·5	481·70	9	5·2	583·57	624·72	77·1	
3	73·5	365·62	9	11·9	401·12	458·33	79·8	Jonval turbine alone.
4	72·0	364·43	9	11·9	404·62	458·92	79·4	

If allowance were made for the height of the Jonval wheel above the tail water, the efficiency would be 83 per cent, instead of 79·8. The number of revolutions given represents those of the brake-shaft; the latter was geared with the shafts of the Jonval and Girard wheels in the ratios of 44 to 112 and 40 to 108 respectively.

G. R. B.

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*Foreign Abstracts. Proc. Inst. C.E.

CORRESPONDENCE.

We do not hold ourselves responsible for the opinions of our Correspondents.

EDISON'S PHONOGRAPH.

To the Editor of "The Practical Engineer."

Sir,—Referring to your article on Mr. Edison's Phonograph, which appeared in your last issue, I would point out that it will have to be a marvellous piece of mechanism if it can do the work of the shorthand writer and reporter, under the conditions that prevail in Parliament, at public meetings, and in the law courts, with the myriad noises and interruptions of all sorts that would be mingled together in the faithful mechanical recorder. Supposing, however, that this difficulty were overcome, a still greater one immediately presents itself, viz., that of revision. In the interest of the speaker himself, a considerable amount of compression is desirable. Until Mr. Edison can succeed in inventing a machine that will summarise quietly and intelligently—until, in other words, he can manufacture a mind—shorthand writers may smile at this idle and impractical talk about the phonograph doing away with their occupation.—Yours, &c., A Shorthand Writer.

London, July 11th.

ENGINEERS' SUMMER HOLIDAYS.

To the Editor of "The Practical Engineer."

Sir,—Engineers, like other mortals, require rest from their toils occasionally, and of course have their usual annual holidays. Where must I go? is often a question not easily answered. I have been for mine, and have perhaps been fortunate in having had a most enjoyable and interesting holiday, so much so that I venture to write suggesting a very good way for other engineers who have not yet spent their holiday. A few days ago, I was (with about 60 other engineers) favoured with permission to visit the great Forth Bridge works. So much having been said and shown in the various engineering papers, I at once decided to make a holiday to see the greatest thing in bridges yet taken in hand. I was, of course, prepared for something out of the ordinary run, and was not disappointed, but really surprised to find that all that had been written and shown in illustrations gave the most meagre idea of what the bridge really is. It is simply beyond description, except to those who have already visited the works. Although ordinary visitors are not actually allowed on the piers and works proper, a very good view of the whole structure and the mode of procedure may be had from the water, either in a small boat or steamer. Seeing that Scotland is generally well spoken of as a holiday resort, this year it is specially interesting to engineers, as there is not only the Forth Bridge, easily reached from Edinburgh by rail, coach, or steamer, at very low rates, but also the great Glasgow Exhibition, which contains novelties not seen at the exhibitions last year. Therefore engineers should have no difficulty in deciding where to go; and I venture to say boiler makers, bridge builders, or metal-plate workers will never again have a chance of such a visit. This summer is most favourable, as the work is perhaps three-fourths completed, and in its most interesting condition for inspection. Here can be seen how two and a quarter millions of money is being spent, in using 54,000 tons of steel and 250,000 tons of masonry to build a bridge, which towers up 360ft. above high water, with spans of 1,710ft. each, under which there is a clear headway of 150ft. above high water, the whole being held together by no less than 8,000,000 rivets. So marvellous is the work, that the general engineer feels very small in his own particular narrow groove.—Yours truly, Scriber.

QUERIES AND REPLIES.

Concave Circular Saw.—Can any reader describe the use of a concave circular saw? It is supposed to be attached to the end of saw spindle outside of bench and driving pulleys.—H. C.

Answer.—In shuttlemaking a concave cutter termed a "saucer cutter" is used for dressing blocks to the right size and bevil. The cutter is screwed on the nose of the lathe mandril, and is about 6in. in diameter. The concavity, however, is merely for clearance.—A. E. W.

Corrosion of Boilers.—Could you kindly help me with your experience in the following matter? A Galloway boiler is being eaten away by the strong acids in the feed. These come from the refuse thrown into the river by adjacent works, and entirely change the natural state of the water. Not a particle of scale will form; and what I wish to discover is how to form a slight incrustation so as to prevent the pitting from penetrating further. If you can advise me as to this I shall feel greatly obliged.—J. J. J.

Answer.—Instead of trying to form a thin scale, it would probably be better to neutralise the acid in the water by the addition of an alkali. For this purpose soda-ash (black ash) is probably the best and cheapest substance to use. It may be introduced into the boiler at the rate of 3lb. to 5lb. per day through the feed, and if it can be introduced in small doses instead of a single gulp, all the better. Possibly a smaller quantity than that mentioned may suffice to neutralise the acid. The exact quantity can be ascertained by testing the water with litmus paper, and the dose should be regulated until the water drawn from the boiler will just turn red litmus test-paper blue. A small book of litmus test-paper may be obtained from almost any chemist for a few coppers. If this treatment does not prove effective, we would recommend you to send a sample of the water to the Litholine Company, Lancaster Avenue, Manchester, and ask their advice, as they make a special study of the treatment of water for steam boilers.

Working Drawings.—Referring to the working drawings which have appeared in your papers, I shall be glad if any of your readers will help me with the following. How is the guide for crosshead fastened to the engine? is it supposed to hang down from the supporting strap by the two top holes? If so, what are the other six holes in each guide for? Ought there to be three more holes in supporting columns for three more supporting straps, as only one is shown in the drawing? Do the transverse distance bars lie across the top of the bearings? also, how are the drag links to be fastened to links, as no place is shown in drawing.—Constant Reader.

Answer.—If "Constant Reader" will refer to the drawings of the cylinders, he will there find provision made for suspending the base plates of the guides from their two upper holes, the other six (as plainly shown) being for the purpose of securing the guide strips to the base plate. The supporting columns are correct as shown, there being only one hole in each necessary, the guide supporting strap spanning the three columns, and fixed thereto by the tranverse distance bars passing through the bottom holes of the guides and those of the columns. Transverse distance bars lie across tops of bearings. Drag links are connected to the links by the link attachment (shown at the bottom of the sheet of drawings III.), and fixed midway between the eccentric rod pin holes under the link block. A skeleton drawing of the general arrangement will follow in due course.—J. R.

Horse Power and Engine.—Can any of your numerous readers inform me what is the maximum horse power I ought to be able to get from the following pair of beam engines, working compound and coupled together with cranks at right angles. H.P. cylinder, 16in. diameter; L.P., 32in. diameter; stroke of each, 6ft., running at 36 revolutions per minute, with an initial pressure of 90lb. per square inch on H.P. piston carried on at that pressure to $\frac{4}{10}$ length of stroke. Would one boiler 28ft. long by 7ft. 6in. diameter, working at 95lb. per square inch, be able to supply steam for same, and what quantity of water would be required per day of ten hours for boiler or boilers supplying steam for that power? Any information will be thankfully received by Constant Reader.

Answer.—Let
P = absolute initial pressure = 90 + 15 = 105lb. per square inch;
p = absolute back pressure against low-pressure piston, 4lb. per square inch;
a = area of high-pressure piston, say 200 square inches;
A = area of low-pressure piston, say 800 square inches;
where $\frac{a}{A} = \frac{1}{4}$ and $\frac{A}{a} = 4$;
S = speed of pistons in feet per minute—432;
L = length of strokes of pistons—6ft.;
$\frac{l}{L}$ = proportion of stroke to point of cut off $\frac{4}{10}$;
hence $\frac{L}{l} = \frac{10}{4} = 2\frac{1}{2}$;
C = aL = capacity of receiver. Therefore $\frac{C}{AL} = \frac{1}{4}$.

When cranks are at right angles

$$PaS\frac{l}{L} \times \Big[1 + \log\Big(\frac{L}{l}\Big) + \Big(\frac{a}{2A} + \frac{C}{AL}\Big)\log\left(\frac{\frac{1}{2} + \frac{C}{AL}}{\frac{a}{2A} + \frac{C}{AL}}\right) + \Big(1 + \frac{a}{2A} + \frac{C}{AL}\Big)$$

$$\log\left(\frac{1 + \frac{a}{2A} + \frac{C}{AL}}{\frac{1}{2} + \frac{a}{A} + \frac{C}{AL}}\right) - \frac{p}{P} \times \frac{L}{l} \times \frac{A}{a}\Big] = \text{foot lbs. per minute.}$$

Replacing these symbols by their corresponding numbers, we have

$$105 \times 200 \times 432 \times \frac{4}{10} \times [1 + {\cdot}91629 + \tfrac{3}{8}\log 2 + 1\tfrac{3}{8}\log 1\tfrac{3}{8} - 0{\cdot}38095] = \text{foot lbs. per minute.}$$

$$105 \times 200 \times 432 \times \frac{4}{10} \times [2{\cdot}23314] = 8103618 \text{ foot lbs. And } \frac{8103618}{33000} = 245 \text{ H.P.}$$

Such a boiler as "Constant Reader" speaks of, with say 38 square feet of grate surface, should produce sufficient steam for such an engine as above, and the quantity of water required for ten hours might be 5,800 or 6,000 gallons if the engine was under full load; if not, the quantity required would be less.—W. A.

Cement for Indiarubber.—What is the best way to cement rubber to steel?—Sandy.

Answer.—I have found the ordinary indiarubber cement, made by dissolving virgin or native indiarubber (not the ordinary vulcanised rubber) in benzine, or bisulphide of carbon, a very satisfactory cement for joining rubber to most materials.—Omicron.

Governor for Portable Engine.—I have a double-cylinder portable engine by Ransome and Sims driving an electric light plant. There are times when I require it to run 70 revolutions, and others when I wish to run 100 revolutions. Can any reader tell me what sort of governor will suit my purpose? The present one gives a great deal of trouble. Sometimes I put a cone pulley on, but if any reader can give me a better idea I shall be much obliged.—C. H. Egypt.

Answer.—If "C. H. Egypt" will place himself in communication with us, and will give us the register number of the engine on the steam chest cover, we shall be happy to give him the information he requires.—Ransome, Sims, and Jefferies, Limited, Orwell Works, Ipswich.

Engine "Constant."—I read in your paper of July 6th a most interesting article on "Vacuum," which has done much to increase my knowledge of the economical working of the compound engine, but I am a little puzzled as to how the "constant" you speak of is obtained, and if you or some of your readers will kindly explain the matter, it will assist me over a barrier that has annoyed me very much.—Aulopile.

Answer.—The "constant" referred to is, really, the horse power of the engine for each pound of mean pressure on the piston, and remains unalterable for the same engine so long as the speed remains the same. It will thus be seen that it is a very convenient expression, as it enables the gain or loss of power arising from any variation in the mean pressure, as shown on the diagram, to be seen at a glance, and enables the power of one cylinder, as far as it depends on diameter and velocity of piston, to be readily compared with that of another. Putting this written explanation, therefore, in the form of a rule, we have:—

Piston constant=H.P of cylinder for one pound of mean pressure exerted throughout the stroke
If C=Piston constant
A=Area of cylinder in square inches
L=Length of stroke in feet
N=Number of revolutions per minute

$$C = \frac{A \times 1\text{lb.} \times L \times 2 \times N}{33{,}000}$$

Removing Black Japan from Steel.—Can any kind reader of your paper inform me as to the best way to remove black Japan varnish from steel?—Sandy.

Answer.—Seeing that in the manufacture of black Japan varnish turpentine is very largely used as a thinning medium, I should imagine that "Sandy" will be able to remove the Japan varnish by means of turpentine applied in sufficient quantity.—Omicron.

Drawing of a Pullman Car.—Could any reader inform me where I could get a working drawing of a Pullman car and a railway carriage?—E. P. S.

Rivet Furnace.—Can any reader of your valuable paper give me some idea of an economical rivet-heating furnace for two stationary riveting machines?—P. H.

Machine for Stamping Nails.—Will one of your readers give me the name of a good firm to manufacture a special press for stamping out nails?—F. C.

Thin Plates.—Can any of the readers of your practical and valuable paper inform me if it is possible to get thin sheets of iron or steel (say 20's gauge) as large as 8ft. 6in. by 4ft. 6in.? If so, where?—Chalkline.

Smoke-consuming Furnace.—Can any of your readers give me the address of the makers of Thompson's smoke-consuming furnace?—J. E.

Hydraulic Jack.—Could any of your readers explain, with rough sketch, the action of Tangye's hydraulic jack, as I cannot get to see the inside of one.—Dover.

Setting Corliss Valves.—Would you, or any of your readers, inform me of the method of setting the above, as made by Ralph Ogden, of Ashton-under-Lyne? A description of the above engine appeared in your issue of May 6, 1887.—Corliss.

Hauling Drum.—I am fitting up a drum to haul stone from a quarry 150 yards deep, with an incline of 45 deg. I have a pinion 7in. in diameter, 1½in. pitch, on crank shaft of 10 H.P. engine, which gears in a spur wheel 2ft. in diameter. On the same shaft is another pinion 10in. in diameter, which drives the drum, 5ft. 6in. in diameter; average load 8 tons. My difficulty is with the teeth of the pinion which gears in the drum, and which keeps giving way. Is the pinion too small, or what is the cause? What would be the strongest way to replace a teeth when one gets broken?—A Subscriber.

Stone-working Machinery.—Can any reader tell me the address of Messrs. Brunton and Frier, makers of stone-working machinery?—G. H.

Book on Differential Wheels.—Can any reader inform me where I can obtain a copy of a book on wheels which was published by a Mr. White in the early part of the present century? The writer, I believe, was awarded a medal by Napoleon I. for a peculiar arrangement of differential gear designed by him, and which forms the leading illustration in the book. I mention this fact as it may assist in identifying the book, and I am not quite sure about its title or the spelling of the name.—Differential.

Emery Wheels.—Can any reader tell me whether it is a common practice to cover emery wheels with the leather in two pieces? For instance, a wheel 21in. diameter, with a periphery speed of 110ft. per second, was covered with leather termed "bull-neck" The leather was found to be 15in. short of going round, and a second making-up piece was put on, the whole being pegged to the wood centre with deal pegs. Is this a dangerous practice or is it not?—A. E. W.

L ng Railway Tunnels.—Will any of your readers be good enough to give me the names of the three longest railway tunnels in England; also state where they are and what companies they belong to.—E. L. Darnall.

Power of Winding Engine.—In calculating the power of a horizontal winding engine, after equalising the moments of the power and the weight round the shaft, what margin of power should be allowed?—Piston Valve.

TO CORRESPONDENTS.

Book on Steam Engine and Indicator Diagrams.—A good book on the steam engine, and one which should probably meet some of the wants of "High-speed Engine" is that by Jamieson, published by C. Griffin and Co., and which was reviewed in our issue of April 27th last. The price of this book is 7s. 6d. There is a want of a good English book on the indicator, and we don't know of any book which would combine a knowledge of the indicator with that of the steam engine in the way you require.

MISCELLANEA.

Glasgow Exhibition.—The record of admissions to the Exhibition since the opening day up to and including Wednesday, the 12th inst., gives a total of 1,759,677.

Range of Lighthouses.—Of Indian lighthouse lights the one that can be distinguished farthest is said to be that of Allepey at Travancore, which has been seen at a distance of 45 miles.

A Chamber of Commerce for Rochdale.—A meeting has been held at Rochdale for the purpose of completing the formation of a Chamber of Commerce for that town. Eighteen manufacturers and tradesmen were appointed a committee, and Mr. W. W. Shaw was elected president and Mr. Alderman Baron, vice-president.

An Exhibition of Workmen's Skill.—An interesting exhibition of the skill of workmen in their own trades will be opened at the Crystal Palace on August 18 in connection with the National Co-operative Festival. The competition will be amongst working men members of the industrial co-operative societies throughout the kingdom. The Council of the Society of Arts—who have promised to appoint the judges—will also award one of their bronze medals in 18 of the principal classes. The secretary, Mr. W. Broomhall, 1, Norfolk Street, Strand, will supply any further particulars.

Ben Nevis Observatory.—Out of the surplus fund from the Edinburgh Exhibition of 1886 it is likely that the sum of £1,000 will be handed over to the Scottish Meteorological Society in aid of the Ben Nevis Observatory scheme, and chiefly in connection with a proposal to complete the Low Level Observatory at Fort William.

Small Circular Saw.—The smallest circular saw in practical use is a tiny disc about the size of a shilling, which is employed for cutting the slits in gold pens. These saws are about as thick as ordinary paper, and revolve some four thousand times per minute. The high velocity keeps them rigid notwithstanding their thinness.

Speed of Water Filtration.—A limit to the rapidity of filtration has been generally adopted by the London water companies; it is represented by the passage of about 540 gallons of water through each square yard of the upper surface area of filter in twenty-four hours, or two and a half gallons through each square foot of surface per hour. Water passed through well-constructed filter beds at a rate not exceeding this becomes, under ordinary conditions, bright and clear.

A Railway from St. Petersburg to Pekin.—The Russian Government is stated to be contemplating the construction of a railway to connect St. Petersburg with Pekin, and, if possible, Shanghai. The towns in Siberia are outbidding each other in their offers to support this undertaking, which would contribute so greatly to their prosperity. The cost of construction would be comparatively trifling, and the line would present but few difficulties, as it would pass mostly through a level country.

Amalgamation of Boiler Inspection Companies.—The Midland Steam Boiler Inspection and Assurance Company, Limited, Wolverhampton, one of the oldest established and most successful in the kingdom, has just been amalgamated with the Scottish Boiler Insurance and Engine Inspection Company, Limited, who during the last three months have also acquired the business of the English and Scottish Boiler Insurance Company of Manchester. Central offices have been opened in Manchester and Birmingham, and as the inspecting staff of both these companies has been retained, the work will go on uninterruptedly as far as the policy holders are concerned.

The Swansea Metal Trade.—The annual meeting of the members of the Swansea Metal Exchange was held on Tuesday, when it was reported that nearly 500 members had joined during the year, representing the copper, iron, steel, tinplate, coal, spelter, gold, silver, chemical, and other industries of the neighbourhood, and a general opinion was prevalent that a permanent home would soon be built. At the banquet which followed, Sir John Jones Jenkins, the president, advocated the taking of steps which would render it unnecessary for South Wales manufacturers to pay a quarterly visit to Birmingham. Buyers from London, Liverpool, Birmingham, and Manchester were already considering the advisability of establishing offices at Swansea.

The Shipping Trade.—From the returns compiled by Lloyd's Register of Shipping, it appears that there were 377 vessels, totalling 608,118 tons gross, under construction in the United Kingdom during the quarter ending June 30, 1888. Of these vessels 300 were steamers, having a total tonnage of 551,071 tons, 82 per cent of which are being built of steel. Of the 77 sailing vessels, 24 are being constructed in steel, 12 in iron, and 41 in wood and composite. The tonnage of the steamers is 551,071, and of the sailers 57,047. During the corresponding period of last year 281 vessels of 418,645 gross tonnage were being built. Ninety per cent of the vessels now being built are being constructed under the supervision of Lloyd's surveyors.

An Electric Kettle.—A kettle heated by electricity has been brought out in America, and may be mentioned as a curiosity in science. The kettle has a thick bottom, in which is placed an electro-magnet. Alternating currents of electricity—that is to say, currents which rapidly change in direction—are sent through the wire of this electro-magnet; and, as a consequence, the iron core of the latter becomes heated by what are technically called the "Foucault currents," generated in it. These induced currents heat the iron, and so warm the water in the kettle, like a fire under it. It will be seen that this is quite a different device from the electric heaters already brought out, in which the heat was obtained by passing the current through a resistance coil of wire.

Proposed Chamber of Arbitration.—A scheme is now under consideration in the city, at the instance of the Corporation and the London Chamber of Commerce, for the creation of a Chamber of Arbitration for the speedy and inexpensive settlement of disputes and differences arising in the course of business. It is suggested that the chamber should be open daily, and the arbitrators should be bankers, brokers, manufacturers, merchants, and other traders, and captains in the mercantile marine, assisted by a registrar to act as legal assessor, and the parties to a dispute should be at liberty, if they wished, to employ professional assistance. The proceedings would be private, unless the disputants expressed a contrary wish. An expression of opinion of merchants and others is now being elicited on the subject before proceeding further.

SELECTED PATENTS.

APPLICATIONS FOR LETTERS PATENT.

October 25th, 1887.

14,504A Pipe Couplings, A. J. Boult, Middlesex. (W. Martin, United States.)—[Complete Specification.]—Note.—This application having been originally included in No. 14,504, dated 25th October, 1887, takes, under Patents Rule 23, that date.

July 5th, 1888.

9771 Screw Propellers, T. Leitch, Glasgow.

9774 Screw Wrench, M. W. Hilles, Dublin.

9777 Centrifugal Pumps, E. Maertcns, Bradford.

9778 Pumps, E. Maertens, Bradford.

9785 Motor, I. Watts and H. G. Gullick, Bristol.

9790 Motive-power Engine, L. Sykes. Manchester.

9799 A Smokeless Explosive, J. A. Wanklyn, London.

July 6th.

9820 Metallic Packings, E. B. Donkin, Bermondsey.

9821 Stone Saws, J. Peckover, Philadelphia.

9832 Ventilators, J. C. Wilson, Denton.

9841 Sight Feed Lubricators, W. James, Chester.

9843 Locking and Unlocking Railway Carriage Doors, F. Biddiscombe and J. Howarth, Manchester.

9844 Steam Boilers, E. N. Barnard, Holborn.

9846 Steam Boiler Furnaces, S. E. F. Ogden and W. Ireland, London.—[Complete Specification.]

9853 Fire Escape, H. W. Tier, London.—[Complete Specification.]

9854 Electrical Accumulators, L. Bristol, London.

July 7th.

9870 Valve Gear, D. A. Murdoch, Princes and Clarendon Docks Engineering Works.

9879 Artificial Fuel, J. Lindler and J. Burn, Sunderland.—[Complete Specification.]

9890 Steam Jet Apparatus, W. B. Cumming, Liverpool.

9892 Compound Steam Engines, W. Hargreaves and W. Inglis, Glasgow.

9897 Chasing Tools, J. W. Newall, London.

9898 Steam Boilers with Divided Fire Tubes, G. Eggers, London.—[Complete Specification.]

9901 Apparatus for Cutting Sheet Metal, J. Pinson, London.

9908 Sand Blast Apparatus, J. E. Mathewson, London.

9910 Dynamo-electric Machines, G. Kapp, Manchester.

9913 Pipe Wrench, T. B. Gilmore, Borringdon.

9923 Type-writers, A. H. Huth, London.

July 9th.

9924 Production of Antiseptic Sprays, A. R. Upward, London.

9926 Ships' Compasses, T. Bassnett, Liverpool.

9927 Make-and-Brake Switch for Secondary Batteries, G. V. Fowler and E. W. Lancaster, trading as Fowler, Lancaster, and Co., London.

9928 Electrical Regulators, G. V. Fowler and E. W. Lancaster, trading as Fowler, Lancaster, and Co., and E. J. Penn, London.

9931 Repeating Sounds, A. A. C. Swinton, London.

9937 Locks and Keys, R. Blain, Belfast.

9942 Paper-making Machine, J. H. Annandale, Glasgow.

9947 Water Motors, H. Raison, Battersea.

9949 Locking Nuts, T. Trussell, Nottingham.

9951 Securing Fish-plates, W. Knowles and J. Smith, London.

9954 A Torpedo, H. N. Morgan, London.

9958 Steam Engine Governors, E. Jones, London.

9961 Torpedoes, M. E. Hall, Middlesex.—[Complete Specification.]

9967 Tube Cutters, S. Pitt, London. (J. W. Mellen, United States.)—[Complete Specification.]

9969 Fire Escapes, E. Edwards, London. (H. Cencelme, France.)

July 10th.

9975 Coupling Pipes, T. L. Daltry, Manchester.

9986 Cement, F. W. S. Stokes, London.

9991 Magneto-electric Apparatus, W. R. Lake, London. (W. Humans, United States.)—[Complete Specification.]

9995 Air-tight Joint, P. Rawlinson, Sheffield.

9999 Screw Propellers, G. E. Sergent, Monmouthshire.

10,002 Apparatus for the Propulsion of Ships, J. Nickholds, London.

10,005 Nails, J. Brown and W. Mackenzie, Glasgow.

10,007 Rotary Motion by means of Compressed Air, E. Farrar, London.

10,009 Apparatus for Consuming Smoke, W. Ackroyd and T. H. Ackroyd, London.

10,023 Construction of Coke Ovens, T. Taylor-Smith, London.

10,024 Pulverising Apparatus, E. Cohen, London.

10,033 Machine Belting, J. H. Cohrs and J. H. F. Cohrs, London.

10,035 Ventilating Stove, R. W. Boyd, London.

10,039 Manufacturing Screw Blanks, C. D. Rogers, London.—[Complete Specification.]

10,040 Manufacture of Wood-screws, C. D. Rogers, London.—[Complete Specification.]

10,044 Automatic Engine Recording Apparatus, E. Harrison, London.

10,045 Brakes, E. J. Hill, London.

10,048 Switching Accumulators, B. M. Drake and J. M. Gorham, London.

10,053 Marine Compasses, W. J. Reynolds, London.

July 11th.

10,066 Ventilators, C. Darrah, London.

10,067 Screw Propellers, F. W. Willcox, Durham.—[Complete Specification.]

10,072 Connecting Pipes, E. Carpenter, London.

10,074 High Steam Safety Valves, G. Spencer, Manchester.

10,079 Ventilators, W. Wright, United States.)—[Complete Specification.]—11th July, 1888.—[Date applied for under Section 103 of the Patents, &c., Act, 1883, 5th June, 1888.]

10,084 Breech-loading Fire-arms, T. Perkes, London.

10,090 Nut Locks, J. W, Throop, London. (T. D. Jones, United States.)

10,098 Apparatus for Purifying Water, A. Howatson, London.

10,101 Ships' Compasses, J. V. Peichl, London.

10,102 Electric Batteries, W. R. Lake, London. (Lacombe and Co., France.)

10,103 Coupling and Uncoupling Wagons, E. J. Hill, London.

10,105 Brakes, J. L. Kctcher, London.

July 12th.

10,115 Operating Drills, B. C. Sykes and G. Blamires, Halifax.

10,117 Brake, O. Mobbs and A. Mulliner, Northampton.

10,120 Steam Generators, F. Livet, London.

10,136 Ventilators, J. Alderman, Middlesex.

10,148 Bearings for Lubricating Purposes, J. W. Heward, Middlesex

PUBLISHERS' ANNOUNCEMENTS.

BACK NUMBERS of "The Practical Engineer," from the commencement, can be obtained at either of our offices in London or Manchester, or by order of any Newsagent.

Vol. I. (bound), containing Nos. 1 to 44 inclusive, from March to December, 1887, price 6s. 6d., can still be obtained by order from any Newsagent, or will be forwarded, carriage paid, from either of our offices on receipt of the amount by postal order or stamps.

Numerous complaints having been made to us by Subscribers of the difficulty they experience in obtaining copies of the *Practical Engineer* in certain districts, we have to state that the Journal can be obtained by any Newsagent through the ordinary trade channels, and no difficulty should therefore exist in obtaining copies by order of any Newsagent.

For the information of the trade, we may state that copies can be obtained from either of our Offices in London or Manchester, or from any of the following wholesale houses.

W. H. SMITH & SON, Strand, London.
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EDITORIAL NOTICES.

All communications for the Editor of this Journal should be addressed to 6, Victoria Station Approach, Manchester.

Communications intended for insertion in the current week's issue should reach us not later than Tuesday Evening.

We cannot undertake to return rejected manuscripts or drawings unless accompanied by a stamped and directed envelope.

Contributors are requested to write on one side only of the paper. Sketches should be sent on separate sheets.

TO ADVERTISERS.

Advertisements intended for insertion in the current issue should reach us on Wednesday morning at the latest.

SPECIAL NOTICE TO SUBSCRIBERS.

As we have frequent complaints from subscribers in remote districts of a difficulty in obtaining their copies regularly through the usual channels, we suggest to such subscribers the advisability of ordering their copies direct from our office, and for this purpose we insert, on page VI., a form of order for The Practical Engineer *to be forwarded through the post. This can be detached and enclosed to us, with the necessary remittance in half-penny postage stamps, and will ensure the punctual and regular delivery of the journal, on* Friday Morning.

THE
PRACTICAL ENGINEER.
JULY 27TH, 1888.

EVAPORATIVE TESTS.

To institute a comparison between the efficiency of one boiler and another appears at first sight to be a very simple matter, and to involve nothing more than the measurement of the amount of water that a given quantity of coal will evaporate in each case.

Although this is true in the abstract, yet the comparison is of little value if the figures alone are taken into account and no regard is paid to the special conditions that prevail in each case. To express the relative merits of steam generating apparatus in figures is not always an easy task, and the conditions may be so widely different as to render it impossible.

The old adage, that "nothing can be made to lie so much as figures," receives no more apt illustration than in the results of evaporative tests that are placed before us from time to time with regard to the merits of some appliance or other in connection with steam boilers; and the number of pounds of water that have been evaporated by a pound of coal at a special trial of the apparatus is invariably pointed out as incontestable evidence of its superiority. We need hardly say the results are frequently astonishing; indeed, imbued as we are with a firm belief in the truth of the modern theory regarding the convertibility of heat and work, their acceptance sometimes makes large demands upon our credulity.

An examination of the conditions under which the test has been made occasionally reveals the cause of the exceptionally high results obtained. This, however, is not always possible, as the bare results are sometimes put forth without a word of explanation as to the conditions under which the trial was made. Against such bare results steam users should be on their guard, and more substantial evidence should be required before they are accepted as correct. Patentees are proverbially prone to look upon their offspring with a favourable eye, and to consider as motes, defects which less prejudiced mortals would regard as beams; while they are certainly not qualified to act as judges in deciding upon the relative merits of rival boilers, or their appliances. A long experience, however, has taught us that steam users very often accept the *ex parte* statements of patentees as facts without taking the trouble to verify them, and the application of novelties is frequently effected in haste only to be repented at leisure.

Even with the best of intentions and the strongest desire to be impartial, it is, as we have stated, difficult to institute a comparison between the results of evaporative tests. With the same boiler and different appliances the task is not easy, but with different boilers, working under different conditions, the difficulty is very much intensified, and to accept the evaporation of a pound of coal as a measure of the relative value of two contrivances under such circumstances would be quite misleading.

In the first place, coal itself varies very widely in quality, so that if two kinds of coal are used the value of each fuel requires to be carefully taken into account in considering the quantities of water evaporated; while different results may be obtained with fuel of precisely the same heating value, the evaporative efficiency depending on a number of conditions such as method and rate of firing, intensity of draught, frequency of cleaning, &c., while these again depend largely on the personal qualities of the stoker engaged.

If, however, all these disturbing elements in the calculation be eliminated, others of even greater magnitude and difficulty often remain. In comparing the results of different boilers, for instance, regard must be paid to the ratio of grate surface to heating surface. The condition of the boiler also as regards accumulation of scale or soot upon the plates has an effect upon the result, and cannot be ignored, while the question of priming is one of vital importance. Unless the dryness of the steam be compared in some way, mere statements as to quantity of water driven out of the boiler per pound of coal burnt beneath it are of no value whatever. The water may have been evaporated entirely in the form of steam, or it may have been largely mingled with spray in consequence of priming.

The question whether any, and what, allowance should be made for clinker and ashes is one on which opinions differ, and in which practice is not uniform. Some contend that the ashes should be entirely deducted from the quantity of coal used, and the result based upon the evaporation of a pound of pure carbon. Without stopping to discuss whether this is or is not the most convenient procedure to adopt, we may point out in passing that to compare the results thus obtained with others based on the impure coal, as we have sometimes seen done, is both unfair and misleading.

Another way in which unfair comparisons are made is by giving the calculated result in one case on the assumption that the water is evaporated at atmospheric pressure, and the feed-water introduced at a temperature of 212°. There is of course no objection to this provided all the results be reduced to the same standard for comparison, but this is not always done, and the unwary steam user, without technical training, is sometimes misled by the artifice.

In pointing out the difficulties of instituting comparisons between the results of evaporative tests, we do not wish it to be understood that we under-estimate their importance, or deprecate the attempt to compare one with another. On the contrary, such results are frequently of great value, and what we are most desirous of guarding steam users against is the attempt to draw too sweeping a conclusion from insufficient data, or to accept as facts what are in reality little more than unsupported statements put forward by interested parties. As will be seen from what has been said, the comparison of one result with another needs to be very carefully made if it is to possess any real value, and to conduct such tests demands special training and experience, and involves a great deal more than the simple measurement of the water evaporated and the coal consumed. A trial, to afford results of any scientific value, requires to be extended over several hours, and necessitates a staff of observers for taking records at short intervals of the temperature of the feed, the pressure and dryness of the steam, the temperature of the gases, &c. The datum line, with regard to the level of the water in the boiler and the coal in the furnaces, requires to be carefully adjusted at the beginning and end of the test, and the whole working of the boiler, in fact, regulating according to definite rules, which for comparison should be the same in each case. In the absence of careful records, which will permit of an accurate balance sheet being drawn up at the end of the experiment, showing the exact distribution of every unit of heat, the results of evaporative tests are comparatively worthless for purposes of comparison.

POLYTECHNIC INSTITUTE FOR SOUTH-WEST LONDON.

SUPPLEMENTING their generous offer of £150,000 for the foundation of several Polytechnic Institutes in the south of London, to which attention was called a few weeks ago, the Charity Commissioners have again come forward and offered to provide a sum of £50,000 with a view to the endowment and support of a similar institution in the south-west of London, on condition that a sum of equal amount is raised by voluntary effort for the site, building, and equipment. An important meeting was held at Chelsea House, under the presidency of Earl Cadogan, a few days ago, in order to consider the scheme. Earl Cadogan has munificently promised a freehold site for the proposed institute in Manresa Road, which has already been approved and accepted by the Charity Commissioners as equivalent to a contribution of £10,000. The noble Chairman, in opening the meeting, said no one could deny the vital importance of Great Britain's commercial and industrial supremacy in the world, nor could it be denied that that supremacy was at present very seriously threatened, and that in the long run the best educated nations would win. Lord Knutsford, in moving a resolution "pledging the meeting to use its best efforts to carry out the proposal," said he could confidently assert that the Education Department would make every effort to forward the cause of technical education, the definition of which he thought was well expressed in the bill introduced to Parliament as "instruction in the principles of science and art applicable to industries, and in the application of special branches of science and art to specific industries and employments." He thought sufficient was hardly known of the large sums already paid by the State for what was really technical education under the Science and Art Department. It was stated during the course of the meeting that several large subscriptions had been already promised, including £1,000 each from the Duke of Westminster and Mr. W. H. Smith, M.P. The success of the scheme is thus practically assured, and the district, which is estimated to contain a working-class population of a quarter of a million, for whom as yet nothing in the way of technical education has been done, will shortly be in possession of an institution capable of affording both education and enjoyment.

WEIGHTS AND MEASURES.

BY the provisions of the Government Bill relating to weights and measures, which has been introduced by Sir M. Hicks-Beach, it is proposed to enact that every weighing machine shall in future be stamped and verified in the same way as weights are at present. The maximum penalty for using fraudulent weights and measures is increased from £10, under the Act of 1878, to £20, while the court is empowered to publish a conviction of an offender under the Act in any manner it thinks desirable—an amendment in the law calculated to act as a wholesome deterrent to fraudulent traders, for the fear of the publication of a conviction on his door post will, we should think, cause even a rogue to give pause. The practice with regard to the sale of coal is also modified in one or two important particulars, which will tend to protect the poor and the purchasers of small quantities. The fundamental regulation with regard to the sale of coal is that it shall be sold by weight only, and not in bulk; where coal is sold in sacks they are to contain exactly either one or two hundredweight, or some aliquot part of the same. At all reasonable times an inspector of weights and measures may, if so authorised by a magistrate, enter a place where coal is kept for sale, and he may stop any vehicle carrying coal for sale, and weigh any sack or load; and if it appears to a court of summary jurisdiction that any sack or load is of less weight than that represented by the seller, there is a possibility of a fine of £5 being imposed.

DEFECTIVE VALVE DESIGN.

INDICATOR diagrams, although always interesting, are apt at times to be somewhat misleading, even in the hands of those most expert at deciphering them, especially when all the conditions under which they are produced are not fully or accurately known. Hence it is not wise always to accept implicitly conclusions based on indicator diagrams, when one is only partially acquainted with the circumstances of working.

We have been led to make these remarks by the diagrams reproduced herewith, which were exhibited some time ago at a lecture on the "Compound Engine," as one of the best examples which the lecturer had met with of the effect produced on the high-pressure diagrams by having the cranks at right angles, with only a limited amount of receiver capacity between the high and low pressure cylinders. It will be observed from the diagrams shown in fig. 1 that the back pressure line rises very sharply in both diagrams in the middle of the piston's return stroke, due, as ninety-nine out of every hundred engineers would tell us, to the closing of the admission or steam valves of the low-pressure cylinder and the consequent compression of the steam in the receiver as the high-pressure piston proceeds on its return stroke, and reduces the volume of the exhaust steam in the receiver, or the pipe space between the high and low pressure cylinders.

Although this conclusion would be partly correct, it is not by any means, in this instance, the true explanation of the abnormally high and rapid rise shown on the diagrams. Through the courtesy of the lecturer above referred to, we have been enabled to obtain particulars of the valves and steam ports of the high-pressure cylinder from which the figures were taken, and an examination of these suggested at once a probable explanation of the distortion in the figures, which a very simple experiment afterwards proved to be correct.

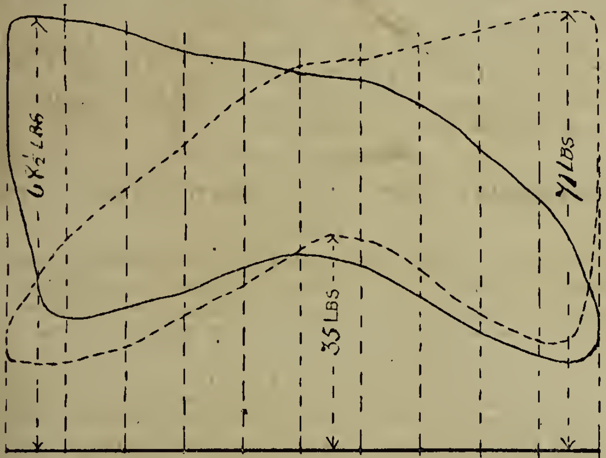

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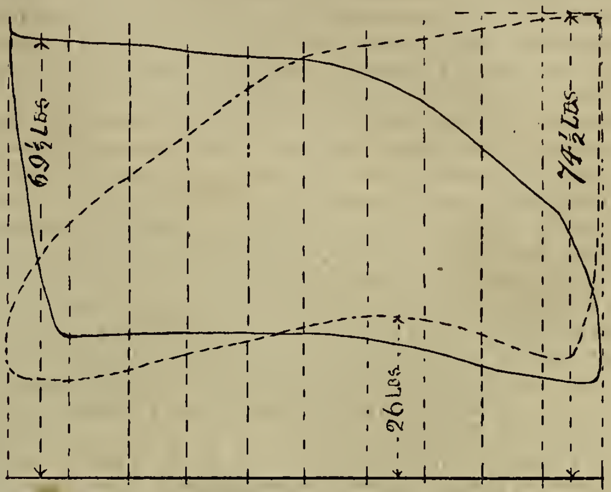
FIG. 1.—Diagrams with full traverse of valve.
Scale: 32lb. equals one inch.

The engine from which the diagrams are taken is one of the horizontal compound type, with the high and low pressure cylinders placed on separate beds side by side, and the cranks at quarter centres, or right angles, *i.e.*, the crank of the high-pressure engine being about 90° in advance of that of the low-pressure.

The steam distribution is effected by plain double slide valves, *i.e.*, by a slide valve placed as near as possible to each end of the cylinder, coupled to the same valve stem, and worked by an eccentric. In fig. 3 are given the dimensions of the valves and ports at the front end of the cylinder, those at the other end being precisely similar, except that they are, of course, the other way about, or on "the other hand." The valves are shown in their middle position, *i.e.*, if the valves were not $\frac{9}{16}$in. "short of cover," or, in other words, if there was not $\frac{9}{16}$in. of negative lap on the exhaust edge, in whichever direction the valves were moving, the steam would just be on the point of release from the cylinder through the opening of the exhaust port. In the position shown, however, owing to the "negative lap" or "shortness of cover" above mentioned, the exhaust is $\frac{9}{16}$in. open at each end when the valve is in the middle of its stroke. The traverse of the valve being 8½in., it has 4¼in. to move before completing its stroke; and, as it will be seen from the accompanying sketch that the inner edge of the valve is only 1$\frac{5}{16}$in. from the edge of the exhaust port, and the width of the port only 2½in., the valve face will move over the exhaust port and $\frac{7}{16}$in. further (since 1$\frac{5}{16}$in. + 2½ + $\frac{7}{16}$ = 4¼in.), closing it up completely and checking the exhaust from high-pressure cylinder before the piston reaches the middle of its stroke, *i.e.*, when it is moving most rapidly. The effect of this will necessarily be to cause the pressure resisting the piston's motion to rise rapidly in the early portion of the return stroke, or during the time when the opening for escape should be greatest, and the result on the diagram is precisely what might be expected under these circumstances, entirely apart from the relative positions of the cranks.

If now the travel of the valves could be shortened, so that instead of having to move 4¼in. and completely shut up the exhaust port, as shown above, the port would only be partially moved over, the restriction would be so much lessened, and the effect on the diagrams would be a considerable reduction in the back pressure line. The valves being worked by the eccentric through rocking levers with slots and studs, means were at hand for effecting this alteration readily, and the valve traverse was accordingly reduced to 6½in. With this traverse the valve would only require to move 3¼in. from the position shown in fig. 3, so that instead of the exhaust port being completely shut up by it, as with the former traverse, there would be an opening of $\frac{9}{16}$in. when the valve was at its full throw (since 2½in. + 1$\frac{5}{16}$in. − 3¼in. = $\frac{9}{16}$in.). The effect of this reduction of traverse is shown on the diagrams, fig. 2, which were taken after this alteration had been made, and it will be seen from these that the extreme back pressure on the high-pressure piston was reduced by the simple expedient of reducing the valve traverse by 2in. from 35lb., as shown in diagrams, fig. 1, to 26lb., as shown in fig. 2.



Practical Engineer.

FIG. 2.—Diagrams with reduced traverse of valve.
Scale: 32lb. equals one inch.

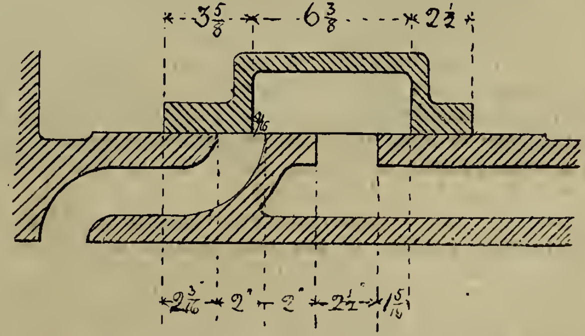


FIG. 3.—Middle position of valve at front end.
Traverse, 8½in.; lap on steam side, 2$\frac{3}{16}$in.; exhaust, $\frac{9}{16}$in. short of cover or negative lap

The valves, of course, were badly designed, and the malformation of the diagrams was, consequently, really due to a fault of construction. Hence it may be urged that had the draughtsman, or whoever designed or set out the valves (if they ever were set out to scale), only known that with valves of this description the length of valve cavity should be *not less* than the breadth of the exhaust port, the bar between the exhaust and steam ports, *plus* half the valve's traverse (the dimensions in this case being, respectively, as shown, 2½in. + 2in. + 4¼in. = 8¾in.), instead of 2⅜in. less than this, the above considerations respecting the dimensions of the valve, &c., need never have been entertained. It was intended originally, however, to show by the diagrams, illustrated in fig. 1, that the position of cranks at right angles in a compound engine was not to be recommended, and this case is a good illustration of how, when every circumstance is not fully known, a principle may be condemned for what in reality is only the result of a fault in detail.

STAYING FOR LANCASHIRE BOILER.

The Lancashire or two-flued boiler has become so widely adopted in this country as a steam generator for stationary manufacturing purposes, and after half a century's experience has proved to possess so many advantages over many of its rivals in the shape of steadiness of steaming, facility for cleaning and inspection, and efficiency, combined with economy in working, especially where large quantities of power are concerned, that we offer no apology for dealing with its construction, especially in view of the great increase in working pressures that has taken place within recent years, and the probability that even the present high pressures will shortly be still further exceeded.

Following the setting plan of this type of boiler given in our issue of the 6th inst., therefore, we give on page 354 of the present number a full-page illustration, showing a method of staying the flat end plates of a Lancashire boiler, 7ft. 6in. in diameter, and suitable for a working pressure of 100lb. on the inch.

To arrange the staying so that it shall give adequate support to the flat ends without rendering them unnecessarily rigid, is a point of considerable importance in boilers of the single or double flued internally fired class. If the ends be made too stiff, there is a serious risk of grooving being set up, either in the end plate at the edge of the upper part of the furnace tube angle iron, or at the root of the angle iron itself. This is more particularly the case at the front end, and arises from the varying thrust of the upper portion of the furnace tube upon the end plate. To avoid the risk of grooving, therefore, a certain breathing space should be allowed between the rivets of the furnace tube angle iron and the lowest rivets of the gussets. This is a point in which a mistake is often made, and with a laudable desire to render the end plate sufficiently strong, the gussets are extended until they almost touch the furnace tube angle iron, the result being that a grooving action is set up when the boiler is put to work, and although the defect under such circumstances may not be a source of danger, yet it gives rise to considerable annoyance and inconvenience, and is sure sooner or later to necessitate extensive repairs.

The arrangement of staying shown in the illustration is one which has been designed by a gentleman who has had extensive and special experience and represents, in fact, the most modern practice of the best makers in Lancashire, which is the home, so to speak, of this class of boiler.

The arrangement of the gussets, it will be seen, follows a simple geometrical construction. The gussets, both at the front and back end, are pitched uniformly at a distance of 21in. apart, measured along the circumference of the shell, except at the bottom of the front end, where the pitch is reduced to 19in., with a view to bring them as close to the mudhole mouthpiece as possible, and thus assist in supporting the flat space below the tubes. At the back end, as there is no mudhole to interfere with the arrangement, a single central gusset stay is adopted. At the front end, all the four outer gussets are set so as to radiate from the centre, while the two intermediate ones are set tangentially to a circle 10in. in diameter. By this arrangement, it will be noticed the vertical centre line of the furnace tube bisects, as nearly as may be, the space between the two outer gussets, and thus affords additional breathing space for the furnace tube where it is most required. At the back end the diameter of the furnace tube is reduced from 3ft. to 2ft. 6in., and the whole of the four outer gussets are arranged as tangents to the 10in. circle.

It will be observed that both at the front and back end the toe rivets of all the gussets at the upper part fall on a circle concentric with and pitched at a distance of 10in. from the rivets in the furnace tube. Experience over a number of years has shown that while this amount of breathing space may be allowed without weakening the end plate, it is desirable that it should not be reduced if grooving is to be avoided. As grooving hardly ever occurs beneath the furnace tubes, the question of breathing space is not of so much importance, and the gussets, in order to afford the requisite support, may be brought closer to the flues, as shown in the drawing.

A word or two of caution may be given with regard to the two longitudinal bolt stays. These, it may be explained, are not absolutely essential on the score of strength, but rather play the part of sentinels, ready to come into action in the event of anything going wrong. They should, therefore, be left a little slack, so as to afford an inch or two of swag at the middle. If the stays are tightened up taut, like fiddle strings, elasticity of the end plates is unduly interfered with, and we have known of more than one case where serious trouble from straining and breakage has arisen from this cause.

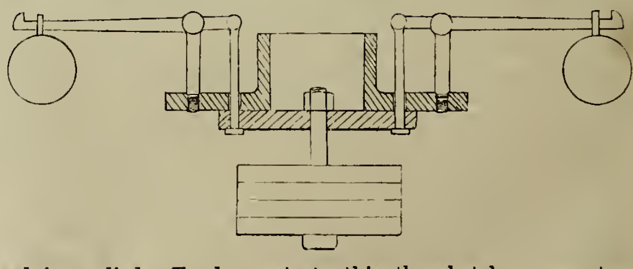
With the staying arranged as shown, the thickness of the end plate should not exceed $\frac{9}{16}$in., and it may be of interest to state that with the scantlings of the gussets, &c., in accordance with the specification given in another column, the maximum bulging under a test pressure of 180lb. on the square inch should, with good workmanship, not exceed about $\frac{1}{8}$in., while there should be no permanent set.

In future issues we propose to give sketches showing the staying for the end plates of other sizes of boilers, both of the Lancashire and Cornish type, arranged in accordance with the principles we have explained.

INTERNAL PRESSURE AND STRESS ON BOLTS.

The strain on bolts securing the covers of vessels subjected to internal pressure or for connecting portions of mechanism is a matter of every-day calculation, but is nevertheless one concerning which there is some confusion of ideas in the minds of many persons of even undisputed experience.

In determining the sizes of bolts two causes of stress require to be considered—the internal pressure or load, and the strain from screwing up. At first sight it would appear that the stress results from the sum of these two strains, and in certain cases this is so, but in others the strain from screwing up is the only one, and in these cases, paradoxical as it may appear, the stress on the bolts is not increased when the internal pressure or the load is applied. To demonstrate this, the sketch represents a portion of a cast-iron vessel with cover, but, in lieu of ordinary bolts, the cover is secured in position by tie bolts attached to weighted levers. It will readily be seen that if weights be hung on the cover, as shown, the facings will not be pulled apart, nor will the pull on the tie bolts be at all increased until the added load is greater than the force exerted by the weights on the levers. When this force and the load are equal, all pressure on the facings will be relieved, and the cover and weights will be in equilibrium; but if the load be then increased, the pull on the tie bolts will also be increased, and the levers will lift.



The same reasoning holds good in the case of pillars or struts in compression, and may be illustrated by the ordinary lever safety valve, where the load on the valve is exerted through the spindle under the lever, or by a direct-loaded spring valve. The pressure on the spindle, or on the spring, as the case may be, cannot be increased by the application of internal pressure until the valve lifts, but the pressure on the seating will be relieved or entirely superseded.

The principle applies also to tie rods or to longitudinal stays for boilers, or, in fact, to any structure in which the strain on bolts or struts is resisted by a fixed or rigid object; also, to a certain extent, to the wire spokes of a cycle wheel where the strain on each spoke is resisted by the spoke diametrically opposite to it, and the stress is not increased by the weight of the rider unless the latter is in excess of the stress already on the spokes.

If the strain on bolt or pillar be due to weight supported only, without fixed resistance, then all additions of weight will increase the load. This is also the case where the resisting structure is not perfectly rigid, and springs to any variation of load or strain, or where a joint is made with a gasket or other elastic packing.

The strain put on bolts by screwing up can only be approximately calculated, but as the length of spanner and the force used are supposed to be proportionate to the strength of bolt, it is usual in determining the size of bolt to calculate from the effective load to be supported—the only accurate datum obtainable—and to allow a sufficient factor of safety to cover all other strains.

Professor Unwin, in his book on "Machine Design," suggests for cylinder covers that the stress to be put on the bolts, and calculated from effective load only, be limited to 2,000lb. per square inch for cylinders 10in. diameter, but increasing for larger sizes up to 6,000lb. for 60in. cylinders; while for roughly-made joints, as for instance with gasket rings, a limit of 1,500lb. is suggested.

CAULKING.

Caulking, viewed in the most favourable light, appears to be little better than a "necessary evil," for if steam or water tight work were always accurately fitted and riveted, and the number, spacing of rivets, and distances from the caulking edges strictly proportionate to the thickness of the material, it does appear possible that "caulking" might, to a large extent, be dispensed with.

Recently we quoted from a contemporary some strictures on "split" caulking, as practised apparently in boilers of light construction. Unfortunately, such improper caulking is not confined to one branch of iron or steel workers; it exists also in shipbuilding and in marine boiler construction. The best mode of obviating this "bad" work is, therefore, a question worthy of serious consideration. To find a remedy, it is necessary, first, to know what renders it necessary, in the opinion of any caulker, to engage in the most reprehensible practice of splitting a portion off from the plate and driving it in with a caulking tool. The answer is that the caulking edges of the butts, or laps, are appreciably open, owing to the riveters not having "plied up" the material between the rivets; or to the plater or boiler-maker not having left the butts sufficiently close. Caulking, then, in such cases, is no remedy, but an unmitigated evil. Even with mechanical riveting badly-closed work is occasionally turned out. The early forms of portable and fixed rivetters—hydraulic and steam—were very efficient in closing rivets, but not for plying-up work. The more recent hydraulic riveters (Tweddel's patent) are, however, reliable tools in this respect, having two rams one within the other, the outer one closing the work, the inner one doing the actual riveting—an improvement, by the way, brought about indirectly by the introduction of the triple-expansion engine requiring marine boilers to be built of 1¼in. and 1½in. plates, to stand the necessarily high-working pressures.

Returning to our immediate subject, we would emphasise the view that in all work, either new or old, only "heavy" caulking or "fullering" should be resorted to. The great bulk of the material should be subjected to the operation. A "nick" should *not* be first made in the material with a small cutting tool.

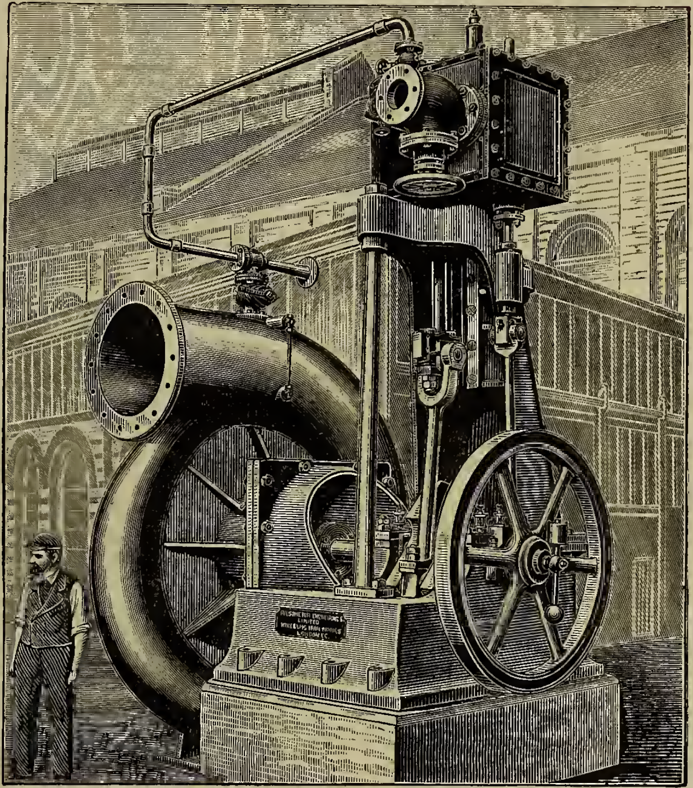
The evil results of improper caulking are not slow to appear. Unfortunately, when they do, they are often aggravated by a repetition of the primary bad treatment. The writer has seen numerous instances of butts in the shell plating of steamers that have been caulked and recaulked until the *butts* have disappeared and a space of one inch and upwards been made, necessitating the fitting of outside butt straps, the packing of the butts, or the condemnal of entire plates. Had the responsible parties declined to have done any recaulking, and contented themselves with carefully applying "mastic" or other suitable cement in the "cracks," such serious repairs would have been avoided, provided the structure was not inherently weak.

Again, in marine boilers it is a mistake to allow of periodical recaulking. If the work has been once efficiently performed, no further caulking should, unless under exceptional circumstances, be necessary in a carefully-managed boiler, and in the case of slight leaks in the lower part of the water-space at the outer sides of the wing furnaces, it is better to internally apply Portland cement.

CENTRIFUGAL PUMPING ENGINE.

The accompanying engraving represents a centrifugal pump, made by the Pulsometer Engineering Co., London. This form of pump is now extensively used for circulating water in the surface condensers of marine engines, as well as for emptying ballast tanks, pumping from the bilges, &c.

The pump shown on engraving has a diameter of 24in., and is capable of discharging 3,000 tons of sea water per hour. The firm makes several varieties of this class of machinery, those intended for marine pumps being arranged so that the bilge water and ballast tanks may be emptied at the same time that water is being circulated through the condensers; thus, in the case of leakage, a large volume of water may be discharged from the vessel without the efficiency of the pump as a circulator being interfered with.



Centrifugal Pump, by the Pulsometer Engineering Co.

The crank shaft, connecting rod, and piston of the engine for driving the pump are made of the best forged steel, while the engine is perfectly balanced, so that it can be run at any speed without the slightest vibration. The lubricating arrangements have also been carefully attended to, and designed so that all the parts may be properly oiled while the engine is running at full speed.

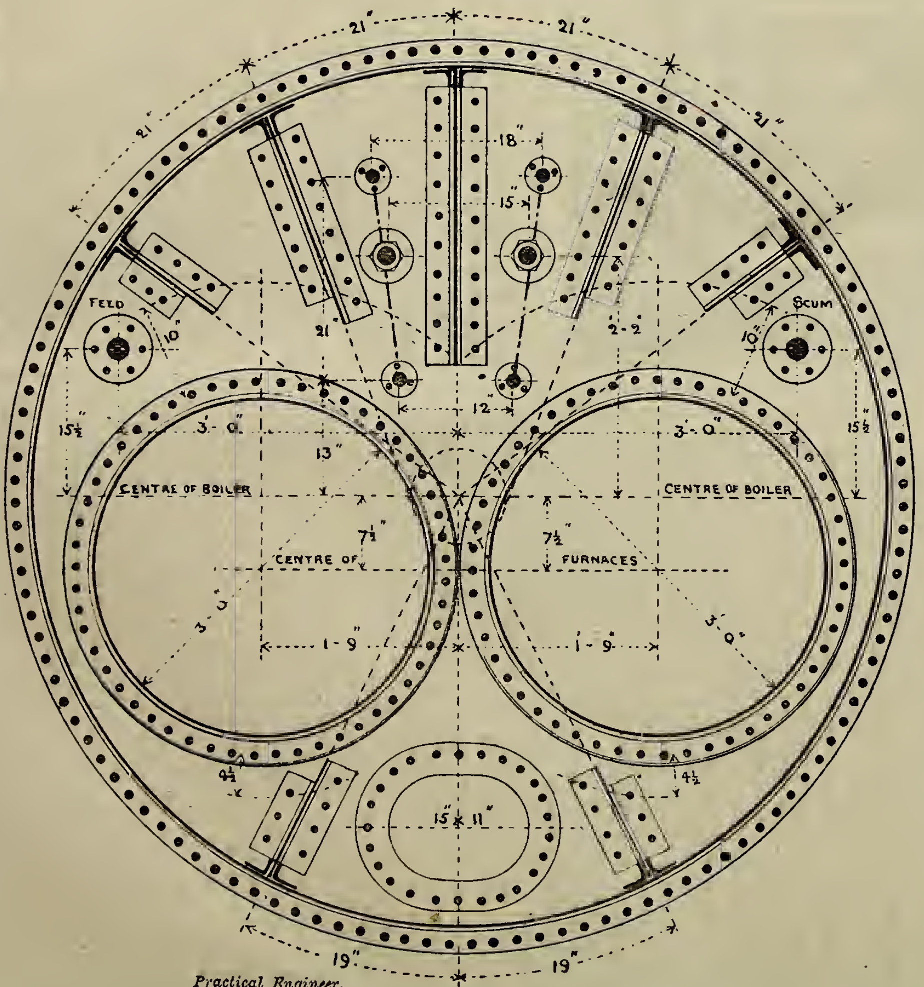
The pumps are arranged to be either driven from the engine direct or by belting, whichever may be most convenient, while the side plates of the casings are constructed so that they can be readily removed and the interior inspected without breaking the joints of either the suction or discharge pipes. Further, by drawing in the suction on either side the propeller is maintained in equilibrium, and all unnecessary friction avoided.

Distribution of Power by Compressed Air.—The length of pipe laid in Paris for the distribution of power by compressed air already exceeds 30 miles. The compressing engines are of 3,000 H.P., and about 3,000,000 cubic feet of air are compressed daily to a pressure of 80lb. per square inch at an expenditure of 50 tons of coal.

STANDARD STAYING FOR END PLATES OF LANCASHIRE BOILER, 7ft. 6in. Diameter.

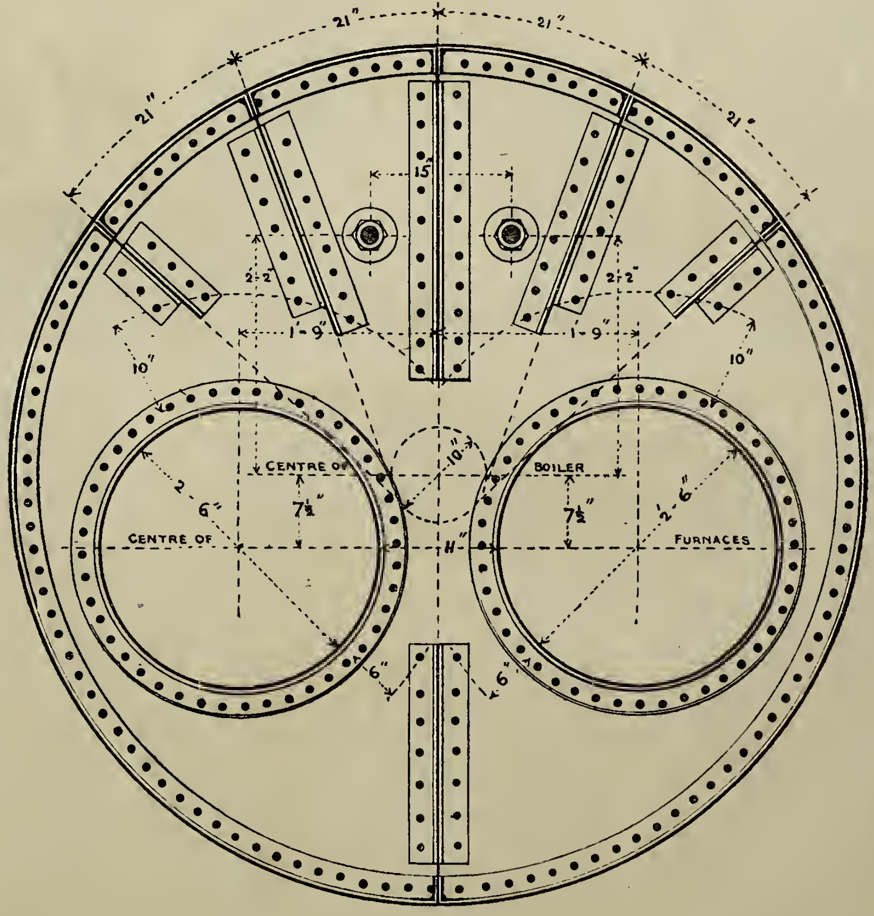
WORKING PRESSURE 100lb. PER SQUARE INCH.

For description see page 352.



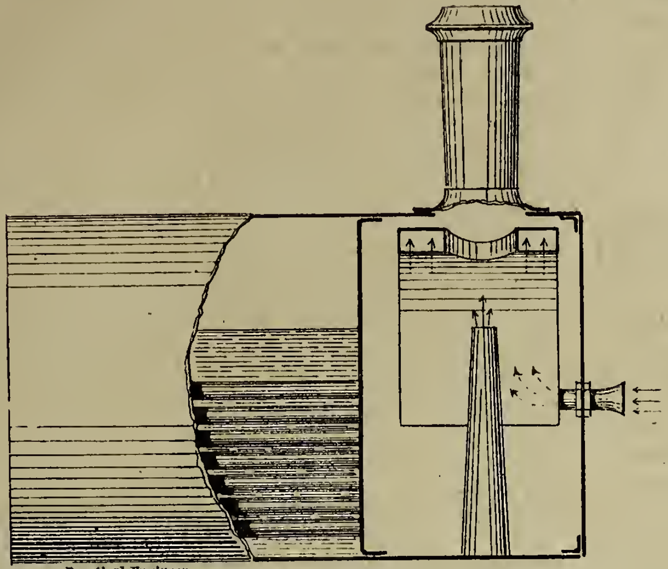
Practical Engineer.

FRONT END.



BACK END.

LANGFIELD'S APPARATUS FOR WARMING RAILWAY CARRIAGES AND TRAMCARS.



Practical Engineer.

Fig. 1.—Longitudinal Section Through Smoke Box.

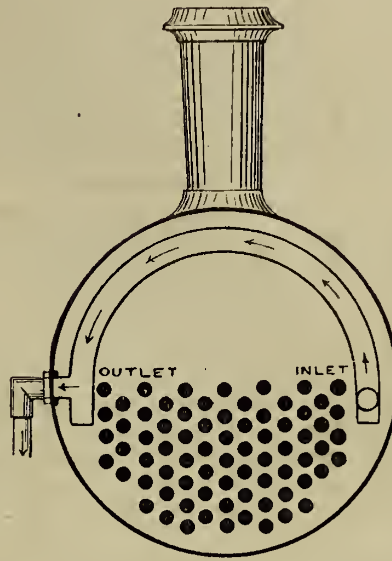


Fig. 2.—End View of Heating Jacket.

The illustration given above shows the method of warming railway carriages and tramcars which has been recently patented by Mr. John Langfield, of Tyldesley, and to which attention was called in a recent issue.

As will be seen from the illustration, the arrangement consists of a semicircular-shaped chamber placed within and concentric with the upper portion of the smoke box of the locomotive or tram engine, as the case may be. This chamber is connected at one side to the front of the engine by a short projecting funnel, open to the atmosphere (fig. 1), so that as the engine moves along, the air, in virtue of its inertia, is swept forward into the chamber, and, after becoming heated, is led off by a pipe at the opposite side of the smoke box to the passenger cars (fig. 2), the distribution and supply of warm air to which can be easily regulated by valves or sliding grids, to suit the passengers' convenience, and placed so as to be under their immediate control.

It will thus be seen that the arrangement solves the question of warming and ventilating railway carriages in an exceedingly simple and satisfactory manner, and in fact the chief merit of the invention lies in its simplicity. It can be easily applied to any existing locomotive or tram engine, at little expense; and as the warming of the air is effected by applying the waste heat from the boiler, which would otherwise pass up the chimney and be lost, the cost of maintenance is nil, while there are no working parts to get out of order.

The discomfort of travelling in winter, and the utter inadequacy of the antiquated method at present in vogue of attempting to heat a railway compartment by means of a solitary foot-warmer placed in it at the beginning of a long journey, will be impressed on the minds of all who are compelled to make much use of our railways. The defect is one that has loudly called for a remedy, and several suggestions have at various times been made with a view to meet it.

It has been proposed to utilise a portion of the exhaust steam from the engine for the purpose by circulating it through the train before discharging it into the atmosphere. But it requires very little consideration to see that such a plan would be open to many objections, as the condensation of the steam would lead to lodgement of water in the pipes, which would require special arrangements to be made for its removal, while in winter time there would be considerable risk of its freezing and choking the pipes with ice. Another objection to the use of steam is the difficulty of making satisfactory joints at the couplings between the carriages, and the inconvenience and annoyance which would arise from leakage as well as the risk of corrosion. Others again have proposed the use of live steam taken direct from the boiler for the purpose of heating. But the objections to this are even greater than to the use of exhaust steam, both on the score of making joints, &c., as well as the serious consequences which might occur in the event of a failure.

With the use of warm air in the manner proposed the objections named disappear, and the coupling up of a train of carriages can be effected by means of a short length of flexible tube and bayonet joint, just as readily as those now used in connection with the vacuum brake.

Mr. Langfield's apparatus is at present in operation on the Bradford Tram Company's line, and its adoption has been attended with complete success. Not only does the air flow through the carriages when the engine is running, but there is also a considerable current when it is standing, and at the time of a visit we paid during cold weather in the spring, the temperature of the car was easily maintained even with the regulating valve partly closed, while the air passing through the pipe, *with the engine standing,* registered 70° Fahrenheit. The arrangement, as we have already stated, is exceedingly simple and effective, and we cannot but think that an apparatus so easily and cheaply applied, and so well calculated to obviate the discomfort of winter travelling, will be widely adopted.

STANDARD SPECIFICATION FOR A LANCASHIRE BOILER.

As full information with regard to the details of construction of a modern Lancashire boiler, in accordance with the best and most recent practice, will doubtless prove of interest and value to many of our readers, we have arranged to publish a complete detailed specification. A diameter of 7ft. 6in., and a working pressure of 100lb., have been selected as being a size and pressure that is often adopted, though, with slight modification, the specification could be readily modified to meet other sizes and pressures.

In order to render the specification more intelligible and explanatory, notes will be appended wherever the text appears to call for it.

Dimensions.

Length of boiler	30ft. 0in.[1]
Diameter of shell	7ft. 6in.
Diameter of furnace tubes	3ft. 0in.
Thickness of plates: Shell	$\frac{9}{16}$in.
„ „ Furnaces	$\frac{7}{16}$in.
„ „ Ends	$\frac{9}{16}$in.
„ „ Cover strips	$\frac{7}{16}$in.
„ „ Gusset webs	$\frac{7}{16}$in.
Shell angle rings	$3\frac{1}{2}$in × $3\frac{1}{2}$in. × $\frac{5}{8}$in.
Gusset angle bars	3in. × 3in. × $\frac{7}{16}$in.
Longitudinal bolt stays—diameter in body	$1\frac{7}{8}$in.

N.B. The diameter of the shell and furnace tubes to be measured internally; that of the shell, inside the outer ring.

MATERIAL.

The boiler to be made of steel throughout, with the exception of the manhole mouthpiece and longitudinal bolt stays, which should be of wrought iron. The rivets may be of wrought iron or steel at the discretion of the boilermaker.

The steel to be of good ductile quality; to have a tenacity not exceeding 30 tons nor less than 26 tons per square inch, and to afford an elongation of at least 20 per cent in a test piece 10in. long. Each plate throughout the boiler to be branded with the measure of its tenacity and ductility.

CONSTRUCTION.

Shell.—The shell to consist of ten parallel belts of plating of equal width, and arranged alternately, so that the first belt at the front end may be an outer one. Each belt of plating to be in one plate circumferentially.[2]

Seams of Rivets.—The longitudinal seams in the shell to be double riveted and made with double cover strips, so that there will be four lines of rivets. The ring seams to be single riveted. The rivets in the longitudinal seams to be arranged on the "chain" system, and to be pitched not less than 2¾in.[3] apart from centre to centre, measured lengthwise of the boiler, and 2¼in. measured transversely. The rivets in the ring seams to be also pitched 2¼in. from centre to centre.

The ends of the cover strips where they tuck under the ring seams may be thinned either by planing or by forging.[4] If the strips are heated for forging or bending, they should be afterwards annealed.

Furnace and Flue Tubes.—The furnace and flue tubes to be truly cylindrical, and each belt to be welded at the longitudinal joint.

Each tube to consist of ten belts of plating united with nine flanged seams, these seams to be arranged so as to fall one 3in. and the other 9in. in front of the ring seams in the shell.

Each tube to taper at the last belt but one from the back end, so as to reduce the diameter from 3ft. to 2ft. 6in., the last belt of plating to be parallel, and 2ft. 6in. in diameter.

End Plates.—The front end plate as well as the back end plate to be each rolled in one piece.

Stays.—Each end to be strengthened with gusset stays, seven at the front end and six at the back, as well as with two longitudinal bolt stays; these stays to be arranged as shown in the sketch on page 354.

Riveting.—All the rivet holes throughout the entire boiler to be drilled, those in the shell after the plates have been rolled and bolted together in position.

Planing Edges of Plates.—The edges of all the plates and cover strips throughout the shell to be planed; the front end plate, as well as the back end plate, to be turned at the furnace tube openings, as well as at the outer edge; the angle ring at the front end to be turned at both edges. The outer edges of all the flanged seams in the furnace tube to be also turned.

Caulking.—The cover strips of the longitudinal seams to be caulked or fullered both internally and externally; the ring seams to be caulked or fullered at the outside overlaps. The flanged seams in the furnace tube to be caulked on the fire side.[5]

Manhole Mouthpiece.—The manhole mouthpiece to be of wrought iron and of raised circular pattern, to have a diameter of 16in., and to be double riveted at its attachment to the shell, the opening in which should be strengthened with an annular strip ring riveted on internally.

The cover of the mouthpiece to be of wrought iron or steel,[6] slightly dished and secured with sixteen bolts, 1in. diameter. The joint surface of the cover and mouthpiece to be faced, and also turned at the outer edge.

Mudhole Mouthpiece.—The mudhole mouthpiece to be oval and of raised internal pattern. The opening to measure 15in. by 11in. in the clear. The mouthpiece to measure not less than 1½in. thick. The internal cover to be secured with two wrought-iron dogs, bolts, and nuts. The mouthpiece to be also fitted with a mock cover, placed externally, and secured with a single central bolt and nut.

Fitting Branches.—The whole of the fitting branches to be in the shape of short standpipes, and made of cast steel.

NOTE 1.—The length may of course require to be modified to suit the convenience of different premises. It is desirable, however, to preserve this length on the score of economy if circumstances will permit.

NOTE 2.—In some shops the tackle will hardly permit of each belt being rolled in a single plate, and, although there is no objection to two plates in a belt beyond the fact that an additional seam of rivets is introduced, it may be of convenience to state that most of the leading shops are now capable of rolling the belts of 8ft. boilers in one plate.

NOTE 3.—There is no objection to this pitch being increased to 3in., but rather an advantage, as the joint is stronger. Some makers, however, are shy of increasing the pitch beyond this for chain riveting with this thickness of plates.

NOTE 4.—Planing, however, is to be preferred as more scientific. The partial heating or working of steel for steam boilers is to be deprecated.

NOTE 5.—The flanged seams are sometimes specified to be caulked on the water side as well as the fire side, but with good work they can be made tight without it, and the less caulking about a boiler the better.

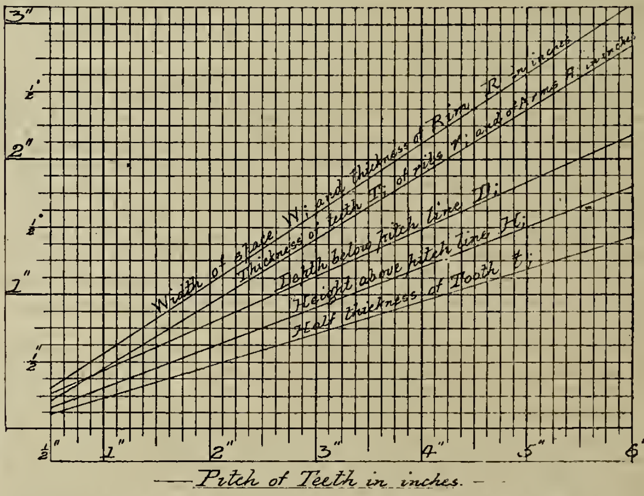
NOTE 6.—If preferred, the cover may be of cast iron suitably strengthened with stiffening ribs on the under side.

(To be continued.)

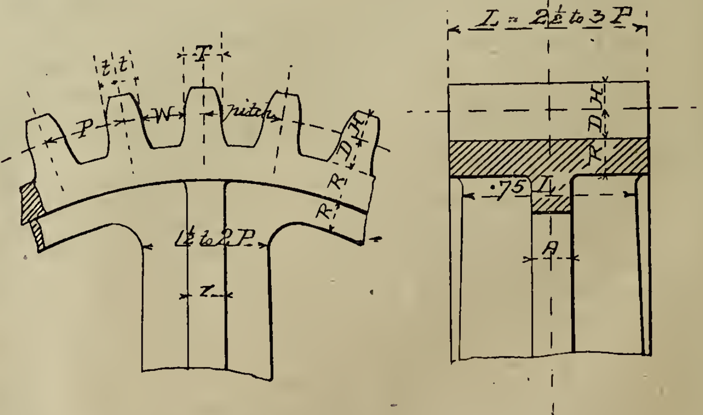
GRAPHIC DIAGRAM OF PROPORTIONS OF WHEEL TEETH.

THE annexed diagram is constructed for the purpose of giving the proportions of the various parts of wheel teeth.

The following example will give an idea of the method of using the diagram.



Required the various dimensions necessary for a wheel having teeth of 4in. pitch.



We note that the various diagonal lines intersect the vertical line marked 4in. pitch as follows :—

Half thickness of tooth, $t = \frac{15}{16}$in.
Height of tooth above pitch line, $H = 1\frac{3}{16}$in.
Depth of tooth below pitch line, $D = 1\frac{1}{2}$in.
Thickness of tooth, T ; of ribs, r ; and of arms, $A = 1\frac{7}{8}$in.
Width of space, $W = 2\frac{1}{8}$in.

Note : The half thickness, *t*, is useful for setting off the teeth on each side of the centre lines of the same. With respect to the other dimensions necessary for wheels, the width of face, L, usually ranges from $2\frac{1}{2}$ to 3 times the pitch.

The length of boss ranges from 2 to 3 times the pitch. The width of arms at the smaller or outer end may be from $1\frac{1}{2}$ times to twice the pitch, tapering towards the boss $\frac{3}{4}$in. in width to a foot in length.

The thickness of metal round the eye of wheel may be from 1 to $1\frac{1}{4}$ times the pitch.

AN ENGINEER'S LIFE AT SEA.—X.

BY A SEA-GOING ENGINEER.

Indicator Diagrams and Balancing of Engines.

In the circuit of the steam through the engines there is much to interest our engineer student. Readiness in interpreting indicator diagrams will be of value to him in the engine-room, and also when he is trying to pass for "chief." Though with new engines on trial trips, or on first voyages, the indicator cannot be dispensed with, yet at all times occasional sets of diagrams are of value. They should be taken under varying conditions, such as when going fast or slow, with engines full open or linked up, ahead or astern, with fair winds and under sail, or beating against head wind and seas, and with the governor on and off. Diagrams thus taken from the same engines, and as nearly as possible in the same working condition otherwise, are of both interest and value, and may enable unexpected questions from the examiner to be correctly answered, besides giving more confidence during the somewhat trying ordeal of examination. By reading and observation our engineer will learn that on diagrams two points at least must always be compared. These, in most cases, are the points of compression and exhaust. Should both of these be early or both late, the eccentric sheave has too much or too little lead, and if this be so the diagrams taken from top and bottom will show the same fault. Should compression be early and exhaust late, or *vice versâ*, then the valve is set too high or too low, and in this case the diagrams taken from top and bottom will vary in opposite directions. A valve too much either way is most readily detected by comparing the points of cut-off in each diagram, for the slightest variation in the valve's position increases the admission at one end by as much as it diminishes that at the other end. This also is near the middle of stroke, at which place the diagram is most sensitive. It may be taken as a general rule that with everything "early" or "late" the eccentric is at fault, and with the compression and exhaust differing from each other at each end, and also from the other end of the cylinder, then the valve is out of position.

A leaky valve shows some of the errors, as in the preceding case, but with some distinctive characters of its own. With either valve or piston leaky, the corners of the diagrams will be rounded and made vague. With a valve leaky, the expansion line will probably be high, with a leaky piston probably low, and with the most rapid fall in the middle, where the cylinder is most worn. Though a leaky valve *may* show too high an exhaust line, a leaky piston *must*, unless neutralised by some other defect, and in the diagrams taken from top and bottom the error will probably be of much the same extent. The rise in the middle of the exhaust in the high-pressure cylinder must not, however, be confounded with this. The rise is due to the exhaust being delivered into a closed receiver. In the middle of the stroke this opens to the low-pressure cylinder, and so the line descends again. If the intermediate receiver be larger or smaller than usual, the curve of this exhaust line will show it. As long as the various points of the diagram are distinctly shown the slide valve is not likely to be out of order, while an expansion line neither too high nor too low tells of a tight piston.

To read diagrams correctly, the engineer must be able to distinguish readily the irregular jerky line due to the indicator piston binding in its cylinder, through being dirty, or because its cylinder has not been allowed to get warm before indicating. With proper care this will not occur. There is also the wavy line due to the spring being too weak for the speed of the engines. In this case the rebound of the spring will be seen in every diagram taken, and the oscillation can be traced all round and allowed for. Then there is the jerky, angular line, telling of water in the cylinder, with its upward jump just before the beginning of the stroke. Too slow a rise of the steam line tells of throttling in admission. Too high a rise, with perhaps a loop at the top, means excessive compression, due to defective setting of valve, or possibly to too little clearance of piston. Valves, it should be noted, may be accurately set in port, but the expansion of the cylinder columns always tends to put them too low when under steam.

Low-pressure diagrams will usually be found much more indefinite in outline than the high-pressure ones. Some of this is due to cooling and condensation in expanding. The temperature of the low-pressure cylinder being an approximation to the *average* temperature of the steam passing through it from its entrance to its exit, it is thus colder than the entering steam, but hotter than that exhausting. The steam condensing at the beginning of the stroke lowers the steam line there, while the water from it, being re-converted into steam again at the end of the stroke, tends to raise the steam line in opposition to the fall due to expansion. This causes rounding and blurring of the outline of the diagram. Some low-pressure cylinders are steam jacketed to prevent condensation; others are only lagged, showing a difference of opinion among makers as to its practical benefit. As having a bearing on the behaviour of the steam, it may be noted that there is also a difference of opinion as to which engine should lead. The high-pressure usually leads, and a reason frequently given is, that as steam must first drive the high-pressure piston before passing to the low-pressure one, it is only natural that the former should lead. Though this is true of the first stroke of the engine, it hardly applies to the engine at work. On the up stroke of the low-pressure piston, and when about half way up, the piston is in quickest motion, and hence its weight is exerting to the full its backward drag. The remaining part of its stroke is also of least efficiency in driving the engine, owing to expansion alone acting, and to compression beginning. If the high-pressure crank leads, then it is turning over its top centre, and the weight of its piston and rods assists more and more the rise of the low-pressure piston and rods. If, however, the low-pressure crank leads, then the weight of the high-pressure piston and rods is being added to that of the low-pressure. Again, it will be found that, owing to the angle of the connecting rod from the vertical, the piston has to travel more quickly during the upper half of its stroke than during its lower half. This causes the rise of the low-pressure piston and rods through the upper part of their stroke to be still more of a drag than they would otherwise be, thus strengthing the reasons given above for making the high-pressure crank lead. With the steam in the cylinders there is also this peculiarity. The steam in the top of the high-pressure cylinder when this piston leads is used at the bottom of the low-pressure one; also that exhausted from the high-pressure cylinder passes into the top of the low-pressure one. Owing to the area of the piston rods deducting from the capacity of the cylinders at their lower ends, we thus have a smaller quantity of steam driving the low-pressure piston down than driving it up. But this is just what is required to neutralise its weight, and it more than makes up for the loss of piston surface on the lower sides due to the area of rod. There is another thing assisting to lift the weight of this piston. The pressure on it is much below that of the atmosphere, even on its steam side, and thus the air exerts a constant upward push on the piston rod. This is readily seen when it is considered that if this piston rod were made very much larger than it is, and the cylinder opened to the condenser on both top and bottom, the suction would draw the piston up to the top of the cylinder by the pressure of air on the rod alone. Thus, though the engines at rest usually drop nearly to their bottom centres unless prevented, yet when under steam a system of balancing is applied to them, which, in addition to the fly-wheel action of the propeller, makes them run with perfect steadiness.

In considering the losses to the engines, the drag of the pumps must not be overlooked. Besides friction, the work of the circulating pump and of the feed and bilge is readily seen. With the air pump, however, it must be remembered that it is not pulling against the vacuum for all its stroke. When at the bottom there is the same vacuum above as below it. As it rises, the attenuated air is compressed on the upper side of the bucket, but only at the top of its stroke, and when the head valve begins to lift, is the full backward pull of the vacuum felt. Like water in the feed pump, the highest pressure does not come on it till it begins to discharge. By shutting off the feed pumps the amount and weight of feed water can be easily ascertained from the overflow pipe. The blast of air at each stroke from the same pipe can be got at approximately. From this the point of discharge and the load of the pump can be calculated. The strain being applied when the bucket is near the top and at its slowest is thus little felt.

Tempering Drills.—Drill points, heated to a cherry red, and tempered by being driven into a bar of lead, will bore through the hardest steel or plate glass without perceptibly blunting.

THE TYPEWRITER AND THE PHONOGRAPH.

An interesting account of the extent to which labour-saving may be effected in offices in connection with the clerical drudgery of writing is afforded by the report in a contemporary of the proceedings in connection with the purchase of the phonograph. The writer states that while the typewriter was busily engaged typing specifications, the gentleman to whom he was presented was dictating letters to the phonograph, conveniently placed on his desk. Busily the machine plied its task, and when the mass of correspondence had been disposed of, a key was depressed, and the machine had done its part of the work. The phonograph was then taken to the clerk to operate it with the Remington typewriter. In connection with the phonograph is a sort of sounder for the ear. The operator of the typewriter, after attaching this sounder to his ear, pressed a key, and as the phonograph reproduced the sounds, letters were typed at the rate of 600 words per minute. Here was a mass of correspondence returned to the principal at the end of two hours, which it would have occupied six hours to accomplish with a pen—a saving of four hours, and an entire absence of tedious manual labour. It is claimed that the Remington typewriter is best adapted for use with the phonograph because of its being comparatively noiseless. The machine is certainly a marvellous one from a mechanical point of view, as well as a brain and labour saving device.

CORRESPONDENCE.

We do not hold ourselves responsible for the opinions of our Correspondents.

THE STRENGTH OF CYLINDRICAL FURNACE TUBES.

To the Editor of "The Practical Engineer."

Sir,—In your notice of the report of the Chief Engineer of the Engine, Boiler, and Employers' Liability Insurance Co., you make a brief reference to the fact that Mr. Longridge, in his report, discusses the question of the strength of cylindrical furnace tubes. I have had the pleasure of seeing a copy of Mr. Longridge's report, and can quite endorse all you say as to the valuable work which is being done in the direction of obtaining and disseminating useful information of a most practical character by boiler insurance companies in general, and by Mr. Longridge in particular. The remarks above referred to will well repay perusal, although some difference of opinion will no doubt be entertained amongst engineers, both with respect to Mr. Longridge's premises and conclusions. Without discussing these at present, I would remark that it would be interesting to know what value Mr. Longridge attaches to the presence of one or two angle-iron or T-iron hoops round a long tube, and how much additional strength may be calculated upon from the presence of say five or six Galloway tubes in the portion of the tube beyond the furnaces, or say a large Rastrick tube. The Board of Trade, I believe, allow little or nothing for the presence of cross water tubes, but there can be no doubt that they must stiffen a tube very considerably to resist collapse, and some information on this point would be useful to many more of your readers besides yours, &c., Young Engineer.

COLLAPSING PRESSURE OF FURNACE TUBES.

To the Editor of "The Practical Engineer."

Sir,—Referring to the formula for collapsing pressure of flue tubes, given by W. J. Ellis in your issue of the 6th inst., I find, as per formula, a tube 3ft. diameter, and made of ⅜in. plates, gives a collapsing pressure of 64lb. Will your correspondent, therefore please say what he would consider *safe* working pressure of above tube, and oblige yours truly, T. Hewitt, Bradford.

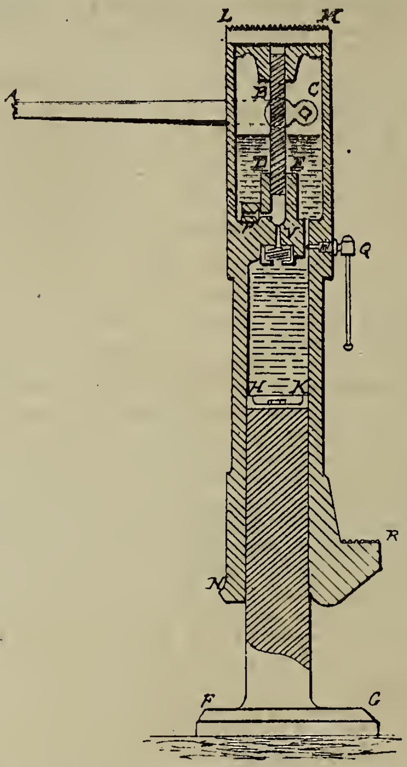
The Summer Meeting of the Institution of Mechanical Engineers will be held in Dublin on Tuesday, 31st inst., and two following days, under the presidency of Mr. Edward H. Carbutt. An influential committee has been formed for the reception of the institution, under the chairmanship of the Right Honourable the Earl of Rosse, F.R.S. On Friday, 3rd August, a visit will be paid to Belfast, on the invitation of a local committee, presided over by the Mayor, Sir James H. Haslett.

Competition in Blacksmiths' Work.—The Worshipful Company of Blacksmiths, London, have given notice that in the month of March, 1889, they propose to offer prizes for and hold an exhibition of work exemplifying the trade of a blacksmith, for which purpose competition is invited amongst the journeymen and apprentices of the said craft in the United Kingdom. Full particulars of the value of the several prizes, of the conditions for the said competition and exhibition, can be obtained on application to Mr. William B. Garrett, clerk to the said company, 16, Water Lane, London, E.C.

QUERIES AND REPLIES.

Hydraulic Jack.—Could any of your readers explain, with rough sketch, the action of Tangye's hydraulic jack, as I cannot get to see the inside of one.—Dover.

Answer.—Probably the following description and sketch, taken from a treatise on mechanics, will suit "Dover": "The hollow cylinder L M N R is raised by the water pressure upon the solid stand or piston H K F G; the roughened surface L M, or the projection at R, being placed beneath the weight to be raised. The upper cistern L M D E is filled with water through a hole in the top, plugged by a screw, which must be loosened when the machine is in use, in order to admit air to replace the water as it is pumped out. A valve at P opening inwards admits the water from the upper cistern to the passage under the plunger B D E, which is worked up and down by an arm B C, whose pivot C passes through the cylinder to the outside, where it is attached to the lever A C. At V there is a valve, kept closed by a spiral spring, which allows the water to be forced down by the plunger. Thus the water is alternately drawn into the passage D E V and forced into the cylinder V H R. The conical screw plug at Q closes a small passage leading from the cylinder V H K into the reservoir above. The water being compressed by the weight is forced slowly through this passage when the screw is loosened. The descent of the weight is under perfect control." The following calculation may also be useful to "Dover":—



Practical Engineer.

Total length of handle AC = 2ft.
Effective length of handle = 1ft. 10in.
Distance BC = 1in.
Diameter of plunger DE = ¾in.
Diameter of piston HK = 2½in., therefore

The ratio of power P to weight W or $\frac{P}{W}$

$$= \frac{BC}{AC} \times \frac{\text{area DE}}{\text{area HK}} = \frac{1}{22} \times \frac{\pi \times \frac{9}{16}}{\pi \times \frac{25}{4}}$$

$$= \frac{1}{22} \times \frac{9}{100} = \frac{9}{2200}$$

so that with a power exerted on the handle with a little over 90lb. we can obtain a lifting force of 10 tons, which is the greatest weight the machine is constructed to raise.—Omicron.

Replies to this query have been also received from "J. R.," Southsea, and "J. A. H.," Middlesbrough, but as they are practically identical with the above, we have not reproduced them.—Ed.

Pitch of Propeller.—Can any of your readers inform me how to alter the pitch of a propeller? Suppose, for instance, a chief engineer receives orders to take the pitch of his propeller by measurement while the steamer is in dry dock, how should he proceed? A sketch would oblige.—Port Glasgow.

Answer.—In reply to "Port Glasgow," I may say there are various methods by which the pitch of a propeller may be obtained, all of which are the same in principle, if not in application. The whole matter lies in a nutshell if the querist will first consider what is the nature of the principle involved. In most text books the form of a helix, or screw thread, is shown to be identical with what is obtained when a slip of paper, cut to the shape of a right-angled triangle *a*, *b*, *c* (fig. 1), is wound round a cylinder—a wooden ruler for instance—whose diameter is such that the point *c* will just meet the point *a*; that is to say, we make the length of the line *ac* equal to the circumference of the cylinder. Now, if we make the line *ab* equal to the pitch, and join *b*, *c*, we have in the line *bc* a representation of the inclination of the surface of the screw—viz., angle *bca*. The angle of this inclination is that which is made use of by "W. A." in *The Practical Engineer* of July 6th. Now, to obtain the pitch of a propeller, all that is necessary for the purpose is that we obtain, at any position on the blade we choose, the diameter that will make a similar triangle to the above, as in fig. 2, of which the side, *b c*, represents the inclination of the blade at that point; *a b* represents the perpendicular distance from a base line which is at right angles to the line of shafting, and then, having obtained the distance *a c*, to make a proportion sum thus: as the length of the line *a c* is to the circumference of the circle passing through that part of the blade being measured, so is the length of the line *a b* to the pitch of the blade at that point. To put the case in a more practical light. Let "Port Glasgow" place across the face of the boss of the propeller a straight edge sufficiently long to reach the desired part of blade (let us assume this for the purpose of illustration to be 4ft. from the centre of shaft); measure, as shown in fig. 3, the distance D from the straightedge to the near edge of blade; then move the straightedge round to the other edge of blade, and measure distance E, and at the same time distance G; subtract distance D from E, and then, as previously explained, as distance G is to circumference of 8ft., so is the *difference* between the two distances D and E to the pitch of the propeller at 8ft. diameter. If the ship is so placed that the propeller shaft is perfectly horizontal, and also at the same time the blade to be measured is lying in a horizontal direction, then a plumb line hanging over the edge of the blade at the edge *d* will fall as shown in dotted lines, and, therefore, the *distance* F (which is equal to the above difference E – D) may be readily obtained. It is very desirable that the pitch should be measured in more than one position on the blade, as it is customary nowadays to make the pitch a varying one (from tip of blade to boss). The pitch of the propeller may be altered provided the blades are "loose"—that is, cast separately from and afterwards bolted to the boss. When thus fitted it is the custom to make the holes in the flange of the blade of an oval shape, in order that the pitch of the blade may be altered by moving the same round the necessary amount. Of course, if the pitch of the blade in its *normal* position is a "true" one, the effect of altering the pitch as above will necessarily make the pitch a "varying" one.—OMICRON.

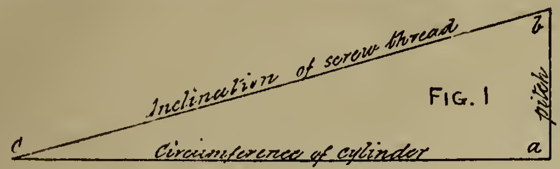


FIG. 1

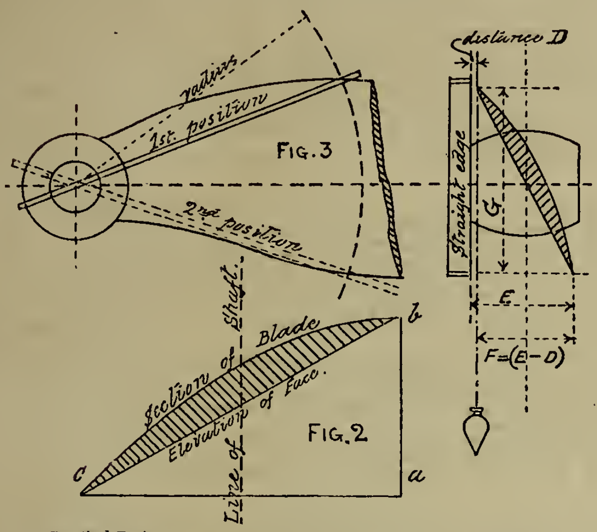


FIG. 3
FIG. 2

Practical Engineer

MARINE ENGINEER.—I intend to become a marine engineer when I have served my apprenticeship, and should be greatly obliged if you would advise me, through your valuable paper, what special study I had better make, and also give the names of a few books bearing on the practical side of the subject. I have read the articles appearing weekly in *The Practical Engineer* with much interest, and should like to get as much more knowledge as possible in my present position. I have a friend chief engineer on a merchant steamer.—MARINE.

Answer.—You will find a reply to the major portion of your inquiry in the answer to "Intending Marine Engineers" in our issue of March 9th last, page 119. With regard to books, Seaton's "Manual of Marine Engineering" is a very comprehensive one, and you might use it in conjunction with the "Notes on Marine Engineering" and "Engineer's Life at Sea" that are appearing in our columns.—ED.

FURNACE FLUES.—Can any of your numerous readers inform me of best recent practice respecting the strength of circular furnace flues such as a Lancashire boiler contains, viz.:—

1st.—The *formulæ* used by the best insurance companies?

2nd.—What *factor of safety* do the formulæ give?

3rd.—Are circumferential lap joints considered as stiffening rings in any respect?

4th.—Demonstrate the above as follows in the case of a Lancashire boiler 22ft. long and 6ft. 4in. diameter.

What would be the collapsing pressure and the safe working pressure of a circular flue 27in. outside diameter, ⅜in. iron, formed of six rings of plates 3ft. 8in. wide, with circumferential and longitudinal lap joints 2½in. wide, single riveted?—WILLIAM J. CRAIG, JUN.

Answer.—The question of strength of furnace tube is one on which much divergency of opinion prevails amongst engineers, and several formulæ are used, all based more or less on the one deduced from Fairbairn's experiments, viz.:—

$$P = \frac{806,300 \times T^{2\cdot19}}{L \times D}$$

where P = collapsing pressure
L = length in feet
D = diameter in inches
T = thickness in inches

The square of the thickness is usually taken, however, in the above formulæ instead of the 2·19 power, as being sufficiently correct in practice.

It is generally acknowledged amongst engineers that Fairbairn's formulæ gives much higher collapsing pressures than tubes prove capable of resisting in actual work, and a modification of the constant based upon the recorded collapses of furnace tubes has been proposed as expressing more nearly the ultimate strength of furnace tubes in actual work, the above formulæ being written with a constant of 375,023 instead of 806,300. Further, the strength of furnace tubes is not a simple function of the length, as expressed by Fairbairn's formulæ, and for short furnace tubes, such as those in vertical boilers, the formulæ is altogether inapplicable, and gives calculated collapsing pressures far exceeding what the tube would be able to resist. For much shorter tubes the rule used by the Board of Trade for marine boilers is probably more correct, viz.:—

$$P = \frac{C \times T^2}{(L+1)\,D}$$

In this formulæ L, D, and T have the same values as before, and C is a variable ranging from 54,000 to 90,000 for iron, according to various details of construction. P is given as the working pressure, but experiments seem to show that within certain limits the formulæ affords a factor of safety of about 4·9.

In estimating the length of the furnace the ring seams are ignored if they are of the ordinary overlap form, as they afford little or no assistance to the tube. The question of factor of safety is one on which there is considerable divergence of opinion, and the insurance companies do not all follow one rule. A pressure which one company might accept another might reject.

It will be seen that the subject is a confusing one, and there is not the unanimity of opinion that might be expected. The fact is that a series of experiments are much needed, in order that the formulæ regarding the strength of furnace tubes may be placed on a satisfactory basis. In the present state of our knowledge, the different boiler companies, in estimating the safe working pressures of furnace tubes, are compelled to consider each case largely on its merits.—ED.

MACHINE FOR STAMPING NAILS.—Will one of your readers give me the name of a good firm to manufacture a special press for stamping out nails?—F. C.

Answer.—I am acquainted with a machine of great merit for "hot forging" nails of all shapes and sizes. These nails are much superior to stamped nails. They are made to a template, and are all exactly alike of any shape or size. If "F. C." likes to communicate with me direct, I shall be happy to afford him any further information.—T. D. C.

HAULING DRUM.—I am fitting up a drum to haul stone from a quarry 150 yards deep, with an incline of 45 deg. I have a pinion 7in. in diameter, 1½in. pitch, on crank shaft of 10 H.P. engine, which gears in a spur wheel 2ft. in diameter. On the same shaft is another pinion 10in. in diameter, which drives the drum, 5ft. 6in. in diameter; average load 8 tons. My difficulty is with the teeth of the pinion which gears in the drum, and which keeps giving way. Is the pinion too small, or what is the cause? What would be the strongest way to replace a tooth when one gets broken?—A SUBSCRIBER.

Answer.—"A Subscriber" does not say what breadth any of his spur wheels and pinions are on the face or teeth; nor does he give us the diameter of the spur wheel on the drum shaft; nor its pitch and that of the pinion which gears with it, and which is the one that gives him the trouble by its frequent failure; so that no one can form any opinion as to the strength of his wheels or their fitness for his purpose. If he will give explicit information on the above points, I will endeavour to assist him.—W. A.

POWER OF WINDING ENGINE.—In calculating the power of a horizontal winding engine, after equalising the moments of the power and the weight round the shaft, what margin of power should be allowed?—PISTON VALVE.

Answer.—After provisionally equalising the moments of the power and weight round the shaft, the provisional power should be multiplied by 2½, to obtain the actual power required for winding, in order that the engine may have sufficient power to raise the load with the required celerity and despatch.—W. A.

EMERY WHEELS.—Can any reader tell me whether it is a common practice to cover emery wheels with the leather in two pieces? For instance, a wheel 21in. diameter, with a periphery speed of 110ft. per second, was covered with leather termed "bull-neck" The leather was found to be 15in. short of going round, and a second making-up piece was put on, the whole being pegged to the wood centre with deal pegs. Is this a dangerous practice or is it not?—A. E. W.

Answer.—In answer to the query of "A. E. W." on emery wheels, I beg to say that I should consider (as I use emery wheels in my work) that the practice of putting leather on the wheel in two pieces to be dangerous, as every extra join adds to the risk of the work being torn from the hand of the workman.—H. G. SUGGETT.

CORROSION OF BOILERS.—I read in your paper of July 20th a reply to "J. J. J." on corrosion of boilers. Would you kindly oblige by explaining to me in this week's issue the meaning of litmus paper, and how by its use you can test the quantity of acid which the water contains? A reply will greatly oblige.—G. H. M.

Answer.—Litmus paper is simply paper that has been soaked in a solution of litmus and then dried. It is extremely sensitive to acids and alkali. A solution containing acid at once turns blue litmus paper red, while a solution of an alkali will turn red litmus paper blue. This property is taken advantage of in testing water for acids or alkali, as by observing the colour it can be readily ascertained which predominates, or if no effect is produced in the paper then it may be concluded that the solution is neutral. The test, however, is only a qualitative one, and affords no clue as to the *quantity of acid* present.—ED.

WHITWORTH SCHOLARSHIPS.—I should be much obliged if any of our kind readers of *The Practical Engineer* could please give full details of Whitworth's Scholarship Examination—how many subjects you have to try for, and what they are, and how many you have to pass.—FITTER.

Answer.—Your best course will be to write to the Secretary of the Science and Art Department, South Kensington, for a copy of the Whitworth Scholarship prospectus. The price is 6d. (post free). This will give you every information.—ED.

WORKING DRAWINGS.—Many thanks to "J. R." for information regarding working drawings. I quite see how the arrangement is now, but has not "J. R." made a mistake in saying the transverse distance bars pass through the bottom holes of base plate; ought it not to be through supporting strap and columns only?—CONSTANT READER.

DRAWING OF A PULLMAN CAR.—Could any reader inform me where I could get a working drawing of a Pullman car and a railway carriage?—E. P. S.

RIVET FURNACE.—Can any reader of your valuable paper give me some idea of an economical rivet-heating furnace for two stationary riveting machines?—P. H.

Smoke-consuming Furnace.—Can any of your readers give me the address of the makers of Thompson's smoke-consuming furnace?—J. E.

Setting Corliss Valves.—Would you, or any of your readers, inform me of the method of setting the above, as made by Ralph Ogden, of Ashton-under-Lyne? A description of the above engine appeared in your issue of May 6, 1887.—Corliss.

Stone-working Machinery.—Can any reader tell me the address of Messrs. Brunton and Trier, makers of stone-working machinery?—G. H.

Book on Differential Wheels.—Can any reader inform me where I can obtain a copy of a book on wheels which was published by a Mr. White in the early part of the present century? The writer, I believe, was awarded a medal by Napoleon I. for a peculiar arrangement of differential gear designed by him, and which forms the leading illustration in the book. I mention this fact as it may assist in identifying the book, and I am not quite sure about its title or the spelling of the name.—Differential.

Long Railway Tunnels.—Will any of your readers be good enough to give me the names of the three longest railway tunnels in England; also state where they are and what companies they belong to.—E. L. Darnall.

TO CORRESPONDENTS.

Corrosion of Boiler.—"F. C. C." would see that an answer to the query regarding this matter was given in our last issue.

Education for Engineers.—To answer all "Milling's" questions fully would mean writing an essay. We may, however, say briefly that a knowledge of elementary algebra is desirable, up to and including simple equations. The first three books of Euclid might also be gone through with advantage. We should not like to say all this is absolutely necessary to become a shop foreman. In fact, we know some very good foremen whose arithmetical or book knowledge is very limited, and yet will do more in five minutes with a two-foot rule, a piece of chalk, and a little common sense, than others will accomplish in a day with a box of instruments and a library. As useful books to study we may mention the following published by Longmans, Green, and Co., at about 3s. 6d.: "Elements of Machine Design," by Unwin; "Elements of Mechanism," by Girdeve; "Principles of Mechanics," by Girdeve; "Strength of Materials," by Anderson. In conclusion, we may say that we cannot promise to answer questions unless the name and address be given, not necessarily for publication, but as a guarantee of good faith.

MISCELLANEA.

Mr. Edison's Phonograph.—Mr. Edison, it is stated, has sold all his rights in the phonograph for something over a million dollars, to the owners of the rival invention the graphophone. There are conflicting reports about the price, but it is said that it exceeds a million. The report that the foreign rights have been sold to an English syndicate for a quarter of a million dollars is authoritatively denied.

Agricultural Machinery in Russia.—A new undertaking is being started at Ekaterinoslaff, Russia, called the Dnieper Agricultural Machinery Works, by a group of Russian and German capitalists. The company will have a capital of £75,000, divided into 1,500 shares of £50 apiece. Its operations will comprise, besides the manufacture of agricultural machinery, that of stationary engines, traction engines, and boiler work.

Annealing Small Tools.—A very good way to anneal a small piece of tool steel is to heat it up in a forge as slowly as possible, and then take two fireboards and lay the hot steel between them and screw them up in a vice. As the steel is hot it sinks into the piece of wood, and is firmly embedded in an almost air-tight charcoal bed, and when taken out cold will be found to be nice and soft. To repeat this will make it as soft as could be wished.

Lighting with Magnesium.—There has recently been installed in a brewery at Marbourg a system of lighting with magnesium, which is stated to give very satisfactory results. The lamps have an intensity of 450 candles, and a single lamp suffices for the lighting of a room of 50ft. by 33ft. The light is, however, much too strong to be employed unshaded for lighting public streets. The price of the lamps is said to be about £6 17s., and the cost of maintenance about 1s. per hour.

Preparation of Rhea.—The Board of Trade have received through the Foreign Office a copy of a decree issued by the French Government containing particulars respecting an international competition of machines and apparatus for the preparation of rhea, applications for admission to which will be received at the French Ministry of Agriculture up to the 10th inst. The decree and a copy of the form of application for admission may be seen on application to the Commercial Department of the Board of Trade, 7, Whitehall Gardens, S.W.

Electric Alarm for Level Crossings.—An electric alarm for protecting level crossings on railways has been devised by Mr. William T. Folks, of Mark Lane, London. At a given distance from the crossing, a spring, placed by the side of the rail, is compressed by the wheels of the engine passing over it. This turns on the current and starts an electric bell which is placed at the crossing point, and which continues ringing until the train has cleared the crossing and has reached a point at a given distance beyond it. Here the flange of the engine-wheel encounters another spring, which it compresses, and causes the bell to cease ringing. The invention is said to have received the approval of several railway engineers.

SELECTED PATENTS.

APPLICATIONS FOR LETTERS PATENT.

July 12th.

10160 Hydraulic Engines, H. Sack, London.
10164 Steam Engines, T. Holehouse, Manchester.
10165 Gas Motor Engine, J. J. Purnell, London.

July 13th.

10173 Lock Nut, G. H. Wells, London.
10181 Furnaces for Smelting Ores, J. Cameron and A. M. Grant, Glasgow.
10182 Apparatus for Making Moulds for Casting, S. Alley and J. A MacLellan, Glasgow.
10191 Apparatus for Spinning, Twisting, Doubling, or Winding, W. P Thompson, Liverpool.
10192 Preservative Material for Coating Iron, &c., J. H. Eastman, Liverpool.
10194 Electrical Switches, A. C. Cockburn, London.
10202 Apparatus for Inserting Rubber into Grooved Tires, C. Challiner, Manchester.
10204 Propelling Ships by Compressed Air, R. Morris, Newcastle-on-Tyne.
10210 Propulsion of Ships, R. Stevenson, London.
10211 Bars for Making Tools, R. Stanfield and T. Clarkson, Battersea.
10212 Locks and Fastenings for Railway Carriage Doors, J. M. Matthews and F. Buckland, jun., London.
10215 Construction of Ships, B. Piffard, Hertfordshire.
10218 Oil Cans, H. Jones, London.
10219 Combined Door Spring and Alarum, R. W. Gamble, London.

June 14th.

10226 Self-acting Mules and Twiners, W. H. Rhodes, Manchester.
10228 Lubricators, H. N. Bickerton, Ashton-under-Lyne.
10234 Axle Boxes, W. Bird, Manchester.
10236 Saddle for Bicycles, J. Forster, Birmingham.
10240 Air Brakes, T. S. E. Dixon, London.—[Complete Specification.]
10241 Locomotives, D. Halpin and I. A. Timmis, Westminster.
10242 Gas Regulators, W. T. Sugg, London.
10248 Apparatus for Shipping and Unshipping Coal, &c., A. W. Robertson, London.
10250 Bearings for Spindles, W. F. Draper and G. A. Draper, London.—[Complete Specification.]
10251 Anatomical Models and Diagrams, D. T. Lee, London.
10254 Preparing Metallic Sheets for Metallic Coating, G. C. Fricker, London.
10259 Repeating Fire-arms, A J. Wake, London.
10260 Metal Tubes, M. Gledhill. London.
10262 Forging Metal Cylinders, &c., M. Gledhill, London.

July 16th.

10265 Life-saving Apparatus, T. Jenks, Bath.
10272 Consumption of Fuel and Smoke-preventing, G. Kendal, Huddersfield.
10277 Loading Coal, &c., T. Freeman, Staffordshire.
10280 Apparatus for Supplying Fuel to Boiler Furnaces. S. Hanson, London.
10281 Utilising Waste Heat for Consuming Smoke, J. Willoughby, A. Gledhill, and J. W. Banister, London.
10286 Magazine Fire-arms, J. Schulhof, London.
10288 Brick-moulding Machines, Z. Pack and J. Pack, London.
10289 Pistons for Steam Engines, S. Robinson and G. Seymour, London.
10291 Locks and Keys, G. Marzari, London.
18298 Curing Smoky Chimneys, J. Way, Chelsea.
10303 Railway Rails and Rail Joints, G. D. Moffat, London.
10307 Liquid Meters and Motors, W. G. Kent and H. S. Price, London.
10308 Smoke-consuming Apparatus, J. Turner, London.
10310 Planing Machines, F. Myers, Liverpool.
10311 Slide Rules, T. Mudd, Liverpool.

July 17th.

10327 Self-starting Dental Engine or Lathe, J. H. Kendall and J. Barkess, Blyth.
10331 Consuming Smoke, R. Macintyre, sen., Sheffield.
10335 Steam Boilers, W. Fairclough, Manchester.
10339 Steam Boilers, J. Tobin, Isle of Wight.
10340 Tool-holders and Tools, J. T. Pedersen, London.
10341 Cages of Hoists, B. G. Smith, Halifax.
10345 Corrosion in Steam Boilers, J. B. Hannay, Glasgow.
10347 Malleable Iron Castings, C. C. Townsend, Madras.
10348 Fire Escapes, A. Tozer, Manchester.
10350 Gas Engines, L. H. Nash, Liverpool.—[Complete Specification.]
10357 Metallic Cartridge Cases, G. W. Roman and O. Andersson, London.—[Complete Specification.]
10363 Multiple Telegraphy, E. J. P. Mercadier, London.
10364 Door Bolt, S. Houghton and J. Baker, London.
10371 Cocks and Taps, R. E. Goolden, London.
10372 Valves and Valve Gear, W. Butterfield, Huddersfield.
10373 Nail-making Machines, P. Haddan, London.—[Complete Specification.]
10374 Rotary Motors, F. Kranich, sen., London.—[Complete Specification.]
10375 Boiler for Heating Horticultural Buildings, W. Ridley, Middlesex.
10376 Car Couplings, D. M. Cowber, London,—[Complete Specification.]
10387 Cranks for Velocipedes, A. J. Boult, Middlesex.—[Complete Specification.]
10392 Steam Engines, E. Edwards, London.
10396 Wire Belting, J. E. Emerson and Thomas Midgley, London.—[Complete Specification.]

July 18th

10406 Jets or Nozzles of Indiarubber Tubes, T. Fletcher and A. Clare, Manchester.
10409 Bolts, S. Williams, Birmingham.
10411 Stop Valves, J. O. Jackson and N. Macbeth, Manchester.
10413 Stuffing-box, G. Macdonald and W. Brown, Leith.
10420 Railway Turn-table, R. Hudson and C. W. Lyon, London.—[Complete Specification.]
10421 Sewing Machines, W. Webster, London.—[Complete Specification.]
10424 Locking Nuts, G. Clark, Sheffield.
10436 Pole for Coupling and Uncoupling Railway Trucks, B. Knights and W. Stacey, London.
10439 Traction Engine Wheels, A. W. Mantle, London.
10443 Injectors, F. B. Johnson, High Holborn.

July 19th.

10447 Sectioning Set Square, W. Parkes and C. Wakeman, Birmingham,
10456 Mould for Making and Pressing Bricks, J. E. Steevenson and S. Eddington, Chelmsford.
10457 Apparatus for Heating Vessels, J. Langfield, Manchester.
10462 Motor Engines, H. Williams, Manchester.

PUBLISHERS' ANNOUNCEMENTS.

BACK NUMBERS of "The Practical Engineer," from the commencement, can be obtained at either of our offices in London or Manchester, or by order of any Newsagent.

Vol. I. (bound), containing Nos. 1 to 44 inclusive, from March to December, 1887, price 6s. 6d., can still be obtained by order from any Newsagent, or will be forwarded, carriage paid, from either of our offices on receipt of the amount by postal order or stamps.

Numerous complaints having been made to us by Subscribers of the difficulty they experience in obtaining copies of the *Practical Engineer* in certain districts, we have to state that the Journal can be obtained by any Newsagent through the ordinary trade channels, and no difficulty should therefore exist in obtaining copies by order of any Newsagent.

For the information of the trade, we may state that copies can be obtained from either of our Offices in London or Manchester, or from any of the following wholesale houses.

W. H. SMITH & SON, Strand, London.
W. H. SMITH & SON, Blackfriars Street, Manchester.
JOHN HEYWOOD, 11, Paternoster Buildings, London, and Deansgate, Manchester.
ABEL HEYWOOD & SON, Oldham Street, Manchester.
J. MENZIES & CO., Hanover Street, Edinburgh.
J. MENZIES & CO., Drury Street, Glasgow.
W. LOVE, 236, Argyle Street, Glasgow.
W. H. CLOUGH, Well Street, Bradford, Yorks.
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CHAS. H. JOHNSON, Corn Exchange, Leeds.
C. CONLAN, 146, Richmond Road, Liverpool.
THOS. HAYNES, 6, James Street, Dock, Cardiff.
R. SIMPSON, 38, Wilson Street, Middlesbro'-on-Tees.
GEORGE BROMBY, 26, Charles Street, Hull.
EDWARD KING, 37, Greyfriars Lane, Coventry.
&c., &c., &c.

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EDITORIAL NOTICES.

All communications for the Editor of this Journal should be addressed to 6, Victoria Station Approach, Manchester.

Communications intended for insertion in the current week's issue should reach us not later than Tuesday Evening.

We cannot undertake to return rejected manuscripts or drawings unless accompanied by a stamped and directed envelope.

Contributors are requested to write on one side only of the paper. Sketches should be sent on separate sheets.

TO ADVERTISERS.

Advertisements intended for insertion in the current issue should reach us on Wednesday morning at the latest.

THE
PRACTICAL ENGINEER.
AUGUST 3RD, 1888.

THE HYDE RAILWAY COLLISION.

After an inquiry extending over a week, the inquest with regard to the railway collision that occurred at Hyde Junction, near Manchester, on July 14th, has resulted in a verdict of "Accidental death."

The collision, it will be remembered, was a very disastrous one, four passengers being killed and about a dozen others seriously injured. From the evidence adduced at the inquest, there can be little doubt that the disaster was due in the first instance to the failure of the leading axle of a four-wheeled passenger coach, in consequence of which the carriage was thrown off the rails, and after running about a quarter of a mile in this way it fell over on its side and collided with a goods train approaching at the moment from the opposite direction.

From the evidence given by Mr. Hopkinson, C.E., of Manchester, at the inquest, it appeared that the axle, which had been in use about seven years, had been flawed for some time, but as the flaw was covered by the boss of the wheel, it could not have been discovered by ordinary inspection. This incipient flaw ran all the way round, and in some places was as much as three-eighths of an inch deep. The larger portion of the fracture, however, was a sudden break, and as the line was straight at the place where the failure first became manifest, and where there would of course be no special strain, Mr. Hopkinson was of opinion that the axle must have met with some unusual shock previous to this. The surface of the fracture was of a crystalline character, and evidently brittle, but no attempt appears to have been made to test the quality of the iron of which the axle was composed, so that we are somewhat in the dark as to whether the crystalline character of the fracture was due to the mode of rupture or to the bad quality of the iron.

The evidence of several of the passengers showed pretty conclusively that had the train been equipped with some arrangement for calling the attention of the driver and guard as soon as the passengers observed something was wrong, the train would in all probability have been brought to rest before anything serious had occurred. Unhappily, however, there was no such appliance, and the passengers, although aware of their danger some time before the collision, were utterly helpless, and could afford no warning to those in charge of the train.

From the evidence of Mr. Pollitt, the general manager of the Manchester, Sheffield, and Lincolnshire Railway, it appears that the company is not in the habit of applying communication cords to their trains except for journeys of more than twenty miles, and as the train was a short-distance one, the usual outside cord was not attached in the present case.

The jury added a rider to their verdict, strongly recommending that, with a view to prevent similar disasters in future, all trains, no matter what distance they had to travel, should be provided with suitable means of communication, and this recommendation, on behalf of the public, we heartily endorse. The question of communication between passengers and drivers or guard is one in respect to which trains in this country are sadly deficient. As a mechanical question, the point presents no great difficulties, and we believe there are several appliances in existence which have been found to work satisfactorily, but that they are not adopted, mainly on the score of expense. Mr. Pollitt, on behalf of his company, stated that they were at present making arrangements with a view to remedy this defect, and he thought with a fair chance of success. This we heartily hope will turn out to be true, both for the credit of railway companies and the safety of the public.

As we have already stated, the question of the quality of the iron of which the axle was composed hardly appears to have received the attention it deserved, but no doubt this point will be fully gone into and thoroughly analysed by Major-General Hutchinson, who has been appointed by the Board of Trade to make the official inquiry.

FIRE INQUESTS.

The first inquiry under the new Act, passed at the instance of the London City Corporation, for enabling all fires, whether fatal or not, to be inquired into by the coroner, was held on Thursday, 26th ult., for the purpose of investigating the origin of the fire which occurred on the previous Sunday on the premises of Messrs. W. Carson and Co., paint manufacturers, Ludgate Hill. The mode of procedure was that followed in the investigation of a death, and the jury consisted of occupiers of premises in the neighbourhood in which the outbreak occurred. The witnesses summoned were the occupiers of the premises, the person who discovered the fire, and the policemen and firemen who were engaged in subduing the conflagration. It is hardly necessary for us to repeat the evidence which was given on the occasion, and which resulted in a verdict to the effect that the cause of the fire was unknown; and we merely call attention to the inquiry as a new departure in connection with the investigation of the origin of fires, and one calculated to be attended with much public advantage. Prior to the passing of the Act, the only inquiry which took place with regard to such occurrences, in the event of their being non-fatal, was that made by the chief superintendent of the fire brigade, with a view to enabling him to draw up his report. This being to a large extent of an informal character, was not as searching as the importance of such occurrences, with their attendant risk to human life, frequently demanded. There is no doubt that numerous cases of gross carelessness, if not of actual criminality, frequently escape censure or punishment in consequence of the difficulty that exists in bringing the responsibility home. The working of the system just inaugurated in London will be watched with considerable interest, and, should it be found satisfactory, we trust steps will be taken to extend the operations of the Act so as to make it applicable throughout the country.

PROPOSED CANAL BETWEEN SHEFFIELD AND GOOLE.

Veritably this is the age of canals, and scarcely a week passes without some new project being broached. The last one proposed is for connecting the towns of Sheffield and Goole, and at a special meeting of the Sheffield Chamber of Commerce, held on Thursday, the 26th ult., a resolution was passed unanimously in favour of its construction. It was urged that the canal was a virtual necessity, if the heavy trade of the town was to be retained. The proposed canal, it was stated, would be fifty miles long, and would pass through Rotherham, Doncaster, and Thorne. The total cost of the scheme, it is estimated, would fall under one million sterling. At the meeting, a letter was read from Mr. Mundella, M.P., in which he stated that he considered the feasibility of the canal was a question of great importance to the traders and manufacturers in the district, and if the scheme were found to be practicable, he should be glad to place his services in Parliament at the command of his constituents, with a view to promoting the enterprise.

FIRE RESCUE EXHIBITION.

On Monday last a somewhat novel exhibition was opened by the Lord Mayor, at the Portman Rooms, Baker Street. The collection of apparatus, which has been officially styled the "Fire Rescue Exhibition," comprise a collection of the most recent inventions in the way of fire alarms, fire extinguishers, and appliances for facilitating escape from burning buildings. The appliances shown at the exhibition, which is the first of the kind ever held, may be divided into three classes. Firstly, those for preventing fires; secondly, those for extinguishing them; and thirdly, those for alarming the inmates of burning buildings and providing means of escape. In the first category may be mentioned exhibits of fireproof cement and chemical preparations rendering upholstery, woodwork, and dress materials non-inflammable. In the second class there were shown hand grenades of various kinds, as well as a number of varieties of fire engines. The third class, however, is probably the one which will excite most general interest; and the ingenuity which has been devoted to the designing of appliances for facilitating the escape of inmates of buildings in the event of fire will probably astonish those persons who are only acquainted with the escapes in ordinary use. In addition to the varieties of fire escapes, a number of electric fire alarms are also shown, including one which rings automatically on the mere presence of fire. The alarm is connected with an air-tight metal box, the expansion of the air in which, when an increase of temperature occurs, rings an electric bell. The exhibition altogether, although very modest in its way, cannot fail to be of interest, and as a means of instructing the public with regard to the resources that are available for dealing with fires must be of considerable value.

LITERATURE.

Numerical Examples in Practical Mechanics and Machine Design. By Robert G. Blaine, Senior Demonstrator, Finsbury Technical College. London: Cassell and Co.

This book is a collection of numerical examples which have been set to the students of the Finsbury Technical College, with a view to illustrate Professor Perry's Lectures on Mechanical Engineering. The majority of text books on mechanics are, unfortunately, very deficient in respect of suitable examples for testing a student's progress, or for illustrating the laws and principles expounded. The defect is one which Mr. Blaine appears to have done a good deal to remedy. The examples, which are of a very practical character, are carefully graduated, and the working of them out will be calculated to give the student a thorough working knowledge of the application of the principles of mechanics to engineering and machine designs. The price of the book is nowhere stated, which is surely an omission in a work of this character.

Water Engineering. By Chas. Slagg, Assoc.M.Inst.C.E. London: Crosby Lockwood and Son.

The matter of which this work is composed appeared largely, in the first instance, in the form of articles contributed by the author to the columns of the *Building News*, and is now reprinted in response to numerous requests that the information should be issued in book form. Advantage has been taken in the republication to add some interesting new matter, and also to re-write some portions of the old. The subject appears to have been treated in a very practical manner, and will be found to be of considerable service to those engineers who are selecting the construction of waterworks as their special branch of the profession, while it contains information which renders it of considerable value as a text book of reference for persons not dealing with this special subject in their everyday practice. The book deals with the construction of embankments, the measurements of rainfalls, the flow of water through conduits and over weirs, while one or two chapters are devoted to the treatment of flood-waters and river conservancy. Several sections of the book are also devoted to the application of water for purposes of power. Like the work we have just reviewed, the price is not stated, and we therefore cannot undertake the responsibility of recommending its purchase. We cannot, for the life of us, divine what objection either the author or the publisher of a book can have to the price being plainly marked on the back. It would certainly be of advantage to readers, for the question of price, quite as much as the quality of the book, affects the matter of purchase.

Journal of the Iron and Steel Institute, Vol. I., 1888. London: E. and F. N. Spon.

This, which is the first volume of the proceedings for the current year, is quite up to the high standard of any of its predecessors, both for quality and quantity, while the printing and editing are everything that could be desired. As several of the papers embodied in the proceedings have already been noticed in our paper, we need not allude to them again. The publication of the proceedings as a half-yearly bound volume, furnished with a copious index, is very much to be commended, and we should be glad to see the Institute of Mechanical Engineers follow the example. The additional cost of issuing the proceedings in a case is comparatively trifling, and not to be compared to the advantages on the score of convenience for reference when the proceedings are placed upon the bookshelf.

INSTITUTE OF MECHANICAL ENGINEERS.

As already announced, the summer meeting of the Institute of Mechanical Engineers is this year being held in Dublin and Belfast, and the proceedings commenced on Tuesday last by the address of Edward H. Carbutt, Esq., president of the institute.

In his presidential address Mr. Carbutt departed somewhat from the usual practice, and instead of confining his remarks to purely mechanical subjects, dealt with some interesting statistics relating to the population and trades of Ireland. We have not space to give the whole of Mr. Carbutt's address in full, and must confine ourselves to a few extracts from his remarks.

Referring to the question of population, Mr. Carbutt, quoting from a paper by Mr. Leonard Courteney, M.P., stated that while in Great Britain at every successive census there had been an increase, in Ireland there had been a decrease, the population, which was over 8,000,000 in 1841, having fallen to less than 5,000,000 in 1887, as will be seen by reference to the following table :—

Year .	1841	1851	1861	1871	1881	1887.
Population .	8,175,000	6,552,000	5,798,000	5,412,000	5,175,000	4,853,000

The births have during this period exceeded the deaths, but the balance has been taken away by emigration. In England, owing mainly to her mineral wealth, the people have become manufacturing, and are thus able to support all the population which leaves the country districts and crowd into the towns. On the other hand, Ireland is mainly an agricultural country, owing partly to the absence of an abundant supply of minerals, and partly to the political action which in years gone by killed her manufacturing trade, especially in woollen goods.

Reference was made to the improvement, however, which had taken place in some branches of manufacture, particularly in the flax and linen trades, the number of persons employed in which had increased from 22,000 in 1850 to 62,000 in 1885. Foreign flax, Mr. Carbutt pointed out, was imported into the United Kingdom to the average extent of 82,911 tons annually, while only 2½% of the total acreage under cultivation in Ireland was devoted to this material, the average produce of the last ten years being a little over 20,000 tons. The Flax Supply Association of Belfast were doing good work in encouraging the growth of this material, and Mr. Carbutt recommended the perusal of their annual report to those interested in the trade. Alluding to the natural poverty of Ireland in respect to minerals, some interesting figures were quoted, from which it appeared that the total number of persons employed in that country in mining in the year 1886 was only 8,164. The production of coal, which was the chief mining industry, was not a growing one, and in fact the output had steadily declined since 1877, and at present only amounted to 100,000 tons. The best Irish coal was the 4-foot seam of the Kilkenny coalfield. This sold for about 20s. per ton, but, unfortunately, the field is almost worked out. Dr. Edward Hull estimates the total available coal in Ireland at 182,280,000 tons ; the seams, however, composing this are very thin, and it becomes a question how soon it will pay to work them.

Turning to the question of Irish railways, Mr. Carbutt referred to the committee appointed to inquire into their working, which reported in 1868 that if all the Irish railways were under one management it would result in a saving of £32,000 per annum. These railways had been constructed partly by public money and partly by private, £4,101,000 having been advanced by Government. Over one million of this sum still remains unpaid, in addition to which there is £115,000 owing for overdue interest. Comparing the railways at the date of the previous visit of the mechanical engineers to Ireland, in 1865, with the present, it appears that, while in 1865 there were seventeen companies, with 1,838 miles of line, in 1886 there were twenty companies, with 2,615 miles. The average increase has been 36 miles a year, and the total increase in train mileage and in gross earnings has been from 30 to 40 per cent. The net return on the capital in 1886 was slightly over 3½ per cent, or about the same as that earned in 1865.

Referring to the question of fares, Mr. Carbutt said this was a point on which no improvement had taken place, while in some cases the fares had even been increased. In England third-class traffic had tripled in fifteen years, while in Ireland it had hardly made any progress. He pointed out that there was not much prospect of improvement in this respect on account of the expensive system of management adopted, and that whereas in Ireland there were 313 railway directors engaged in the management of a total annual income of £3,000,000, the Great Western Railway in England, which had a greater mileage, and an annual income of £5,000,000, was managed by nineteen directors. With a view to remedy this extravagance of management, Mr. Carbutt supported the recommendations of the commissions of Sir James Allport and of the Duke of Devonshire in favour of amalgamation.

Mr. Carbutt gave some interesting figures showing the relative cost of the carriage by sea and by land. Taking the modern cargo vessel with a tonnage of about 2,000 tons, and driven at the rate of about 9½ knots per hour, the cost of carriage amounted to a little less than a penny per mile for each 100 tons. Comparing this with the cost of railway haulage on a good road, with gradients say of about 1 in 350, and taking a mineral train with a gross load of 560 tons, worked with 40lb. of fair average coal per train mile, with a speed of from 12 to 15 miles per hour, the cost of railway haulage per 100 tons of paying load would be a little over ½d. per mile for coal. The charges on railways were, however, very heavy ; and taking the working cost at about 50 per cent of the receipts, the total working cost for each 100 tons of paying load of the train referred to would amount to 11d. per mile. Both marine and railway haulage, however, are cheaper than the horse or the traction engine ; horse haulage costing about 8d. to 9d. per ton per mile, and traction engines about 2½d. to 3d.

Mr. Carbutt made some interesting references to technical education, but want of space forbids our quoting them on the present occasion.

On the conclusion of the president's address, a paper was read by the Right Hon. the Earl of Rosse, F.R.S., on "A description of a balanced or automatic sluice for weirs," of which we hope to give details in a future issue, and also another paper by Sir Howard Grubb, F.R.S., on "The latest improvements in the clock-driving apparatus of astronomical telescopes."

After the reading of the papers, the members partook of luncheon in the dining-hall of Trinity College, by invitation of the local committee, and afterwards proceeded on board a special steamer, which had been kindly placed at their disposal by the London and North-Western Railway Company, to enable them to take a trip round Dublin Bay and view the Alexandra basin, the dredging operations in connection with the deep-water quays, the Bailey Lighthouse, Kingstown, &c.

The Cost of Royal Commissions.—A Parliamentary paper has been published by the Treasury containing a return of all Royal Commissions issued in each year since 1874, specifying the names of the commissioners and secretaries, the date of each report, and the cost of each. The enumeration of them fills 25 quarto pages. Some of them have involved a heavy expenditure. For instance, the Royal Commission on Agricultural Interests, appointed in 1878, cost over £24,000. The Royal Commission appointed in the following year to inquire into the prevention of explosions in coal mines spent over £8,000. The Commission appointed in 1882 on the Endowed Institutions (Scotland) Act involved an expenditure of over £10,000, and the Crofters and Cottars Commission of 1883 cost nearly £6,000. The number of the Royal Commissions costing from £2,000 to £3,000 is legion.

COPPER STEAM PIPES FOR HIGH PRESSURES.*

As might have been expected, the disastrous explosion of the main steam pipe and consequent loss of life that occurred on board the Royal Mail steamer Elbe in September last, and a similar explosion on board the North German Lloyd's mail steam Lahn, have led to investigations as to the cause of these accidents; and, further, the whole subject of the manufacture of copper steam pipes has been considered generally, and experiments carried out with the view of ascertaining the behaviour of the different kinds of commercial copper under various conditions of treatment and at various temperatures. A summary of the investigations and the results of these experiments will not, I think, be without interest to these meetings.

The s.s. Elbe was built in 1870 by Messrs. J. Elder and Co., and fitted with ordinary compound engines. In February of last year she was placed in the hands of Messrs. Oswald Mordaunt and Co., of Southampton, for the purpose of being fitted with new boilers to work at a pressure of 150lb. per square inch, and of having her compound engines converted into triple-expansive ones. This work was completed, and the vessel was running her official trial in Stokes Bay, when the main steam pipe abreast of the after boilers burst, and all in the stokehole at the time, numbering eleven persons, were killed by the sudden outrush of steam.

The s.s. Lahn is a new vessel, built by the Fairfield Shipbuilding and Engineering Company last year. In March last, while on her second voyage across the Atlantic, her steam pipe burst in a somewhat similar manner, but the loss of life was less in this instance than in the case of the Elbe.

It was natural to suppose that the bursting of copper steam pipes, such as those of the Elbe and the Lahn, would be found to be attributable to defective workmanship or material, and that due care had not been exercised in the manufacture of the pipes; but these investigations go to show that elements of very serious danger enter into the ordinary methods of making brazed copper pipes, especially when intended for high-pressure steam.

The steam pipe which exploded on board the Elbe was 9⅜in. in diameter inside, and 6ft. 6in. long; the thickness of the copper was ·276 of an inch, corresponding to No. 2 imperial wire gauze; it was brazed in the usual manner, with a lapped joint, and to all appearance seemed a well-made pipe.

The pipe itself had been tested by hydraulic pressure on two occasions, once for the satisfaction of the builders to a pressure of 300lb. per square inch, and a second time by the owner's representative to 350lb. per square inch.

Test pieces were cut from the exploded pipe, and the copper away from the locality of the brazing was found to have an ultimate tenacity of 33,000lb. per square inch, with an elongation before fracture of 33 per cent in a length of 5in., so that the bursting pressure for this pipe, in its cold state, should have been about 1,940lb. per square inch, being thirteen times the working pressure, or, taking the actual thickness of the copper at the fracture as measured after the explosion, and which was found to be $\frac{3}{16}$th of an inch, the pipe should still have borne an ultimate pressure of 1,220lb. per square inch, or 8·8 times the working pressure.

In order to ascertain the actual strength of the portions of the pipe adjacent to the exploded part, a piece of the pipe, about 30in. long, cut from the portion still intact of the length which exploded, and two other similar pieces were prepared from the next adjoining length of pipe. These short pieces were fitted with flanges and tested to destruction by hydraulic pressure, and in each case the pipe burst in exactly the same way, namely, through the copper near and parallel to the brazed seam, commencing near to one of the flanges.

The pieces taken from the same length where the explosion had occurred gave way under a hydraulic pressure of 780lb. per square inch, the fracture exhibiting a granular and in part a discoloured appearance.

Of the two pieces cut from the next adjoining length of pipe, one burst at 600lb. per square inch with the same granular and partly discoloured fracture, as if the metal had been injured or partially cracked through during the operation of brazing; and the other burst at 1,140lb. per square inch, the fracture being granular, but not discoloured.

This great diversity in the bursting pressures for pipes of the same dimensions and material, and the similarity in the character and position of the fracture in each case, together with the fact that the pressure at which the strongest of these lengths burst was still not more than five-eighths of the calculated bursting pressure, seemed clearly to indicate that the material had been injured in the neighbourhood of the seam by the operation of brazing.

Some very careful experiments to ascertain the effect of increased temperatures upon sheet copper were made by the Franklin Institute in America as long ago as 1837, when strips of copper were pulled asunder in a properly designed machine at temperatures ranging from 122 deg. to 1,332 deg. Fahr., and, as will be seen by the following table, the falling off in strength as the temperatures increased was very considerable, until at 1,332 deg. Fahr., or a bright red heat, the tenacity was nil.

Experiments made at the Franklin Institute, America, in connection with an Investigation into the Strength of Boilers.

Temperature above 32°.	Diminution of Strength.	Temperature above 32°.	Diminution of Strength.
90°	0·0175	660°	0·3425
180°	0·0540	769°	0·4389
270°	0·0926	812°	0·4944
360°	0 1513	880°	0·5581
450°	0·2046	984°	0·6691
460°	0·2133	1,000°	0·6741
513°	0·2446	1,200°	0·8861
529°	0·2558	1,300°	1·0000

From the table it will be seen that at 360° F., or the temperature of steam of 150lb. pressure, copper has about 15 per cent less tensile strength than when cold. But allowing for this falling off in tenacity, the steam pipe of the Elbe at 150lb. steam pressure should still have had a factor of safety of 8½.

Carefully examined through a microscope, the difference in the structure of the copper in the neighbourhood of the brazing where the exploded pipe and those afterwards tested gave way, and the structure in that part of the pipe away from the brazing was very marked, and was clearly to be ascribed to the heating of the copper during brazing.

Test pieces were cut from the pipe near to the brazed seam where the rent had occurred, and it was found that whereas the copper from other parts of the pipe showed a tenacity of 33,000lb. per square inch with an elongation of 33 per cent in 5in. and 59 per cent contraction of area as recorded above, in these pieces the tenacity was only 24,418lb. per square inch, the elongation only 4·6 per cent, and the contraction of area at the fracture only 13 per cent. This result was amply confirmed by testing other strips cut from the same locality; they each showed that the copper near the brazing had lost its ductile qualities and much of its tenacity.

In order to obtain further information on this point, the following experiments were made:—

1. A strip of good copper was cut from a sheet and bent and broken cold.
2. A similar piece was raised to a heat above that necessary for brazing, when it became red short, and broke with its own weight.
3. A piece was raised to the same bright heat as No. 2, allowed to cool, and then broken cold.
4. A piece was raised to the same brittle heat, at which it was partially broken through, then allowed to cool, and the fracture completed when cold.

The appearances of these fractures were very interesting, as may be seen in the specimens on the table. The first had the fibrous silky appearance of a good copper; in the second piece the fracture was coarse and blackened by the heat; but the third specimen seemed to have almost completely regained its tenacity and ductility on cooling, the copper in its normal state having a tenacity of 35,212lb. per square inch, with an elongation of 40 per cent in 5in., and a contraction of area at the fracture of 39·9 per cent; and the third specimen, although it has been raised to a blistering heat, was, when cold, found to have a tenacity of 31,337lb. per square inch, with an elongation and contraction of area at fracture practically the same as the normal copper, which would appear to show that, although the copper should be overheated in brazing, if not otherwise injured, its qualities will be substantially regained on cooling.

The fourth piece was partially broken while hot, and the appearance of that part of the fracture was discoloured by the action of the heat, but the part that was allowed to cool had its ductility restored, and afterwards broke with a bright fracture. This experiment was repeated a number of times, with similar results, and the fractures corresponded *exactly* in appearances not only with that of the exploded pipe, but also with those of the *other pipes* which were experimented upon, and which burst at pressures of 600lb. and 780lb. per square inch respectively.

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* Paper by W. Parker, Esq., Chief Engineer Surveyor, Lloyd's Register. Read at the Institution of Naval Architects, July 25, 1888.

The only difference in these fractures was the depth to which the partial crack, as shown by discoloration, had extended.

In this manner the exact appearance of the fractures of the exploded pipe, and of those experimental pieces which burst at the low pressures, was *reproduced artificially* by burning the copper and treating it in the way described.

From this it will be seen that, should a copper pipe be overheated during the brazing operation, and seeing that the metal becomes perfectly brittle at not much above brazing heat, the pipe might accidentally be cracked when in this brittle condition; and although the section of metal still remaining intact might be sufficient to sustain the cold water test pressure, yet the hot steam and accompanying strains might develop and deepen the crack, and the pipe ultimately give way at the working pressure.

This I consider to be the true explanation of the explosion of the Elbe's steam pipe, and also that of the S.S. Lahn.

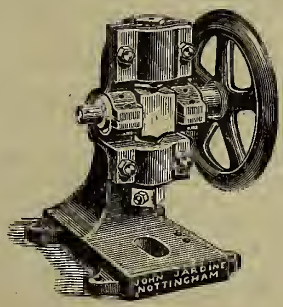
A serious element of danger is thus shown to exist in the present practice of brazing large, heavy copper pipes intended to be subjected to the high pressures now so common. It is generally admitted that welds or brazed joints in any material must possess certain elements of uncertainty, and the above experiments show this uncertainty to be greatly increased in the case of copper worked over a fire.

How to eliminate these elements of danger becomes an important question. Various alternatives suggested themselves, as, for instance, that the copper might be worked cold and the joint made by a riveted seam, that brazed pipes might be served with wire or have strengthening bands fitted at short intervals (both of which systems I find are now resorted to), or that steel pipes might be used, the seam being riveted.

(To be continued.)

SMALL ECCENTRIC PRESS.

The accompanying engraving represents a form of press which is extremely handy for embossing or punching holes in sheet brass. The punch is actuated by an eccentric, which affords a stroke of about half an inch. The eccentric is made out of one piece of cast steel, and the press appears to be well adapted for the purpose for which it is designed, and for many purposes is stated to be preferable to the ordinary fly-press. We have examined specimens of the work performed by the machine, and it appears to be very satisfactorily executed. The maker of the press is Mr. John Jardine, Nottingham.



THE OSCILLATION OF HIGH CHIMNEYS.

The *Mémoires de la Société des Ingenieurs Civils* gives some interesting particulars with regard to the oscillations of a chimney stack near Marseilles. The chimney was 115ft. high, and had an external diameter at the top of 4ft. During a severe storm it was determined, by observing the shadow of the chimney, that its greatest oscillation was 1ft. 8in. It was further observed that a chimney set in motion by a gust of wind oscillates from four to five times backwards and forwards until it is at rest again M. E. Burg asserts that should this momentum during the oscillations of a chimney repeat itself in such a manner that its direction coincides with that of the oscillation, the overthrow of the chimney may be expected. This is the explanation given for the destruction of many a chimney constructed in accordance with sound principles of stability. The *Oesterreichische Zeitschrift für Berg-und Hüttenwesen* adds to this statement the qualification that in the case of a chimney near Vienna, 50 metres (164ft.) high, and constructed of concentric (hollow) rings, with an inner diameter at the top of 2 metres (6½ft.), which is exposed to considerable gusts of wind, the oscillations were most carefully and repeatedly measured with a theodolite, when the observations showed an extreme oscillation of only 16 centimetres (6½in.) during severe storms.

MARINE ENGINE CRANK AND SCREW SHAFTING.

Up to quite recently the Lloyd's Committee have not issued a rule by means of which their surveyors were enabled to calculate the working pressure to be allowed for crank and screw shafting, but they have just issued what will probably be found a more or less satisfactory rule for the same, and which is as follows :—

Lloyd's Rule for Crank and Straight Shafting.

The diameters of crank and straight shafting are not to be less than those found by the following formulæ :—

$$d = \sqrt[3]{\frac{P\,S\,D^2}{c}}$$

where d = diameter of shaft in inches.
P = absolute pressure in lbs. per square inch.
S = stroke of piston in inches.
D = diameter of low-pressure cylinder in inches.
c = constant from following table.

Table of Constants, c.

	For Crank and Propeller Shafts.	For Intermediate Shafting.
Double Expansion Engines…………	10,800	12,300
Triple Expansion Engines…………	18,800	21,200
Quadruple Expansion Engines………	20,800	23,500

It will be noticed that the sizes of the high-pressure and intermediate pressure cylinders do not affect the formulæ, as is also the case with regard to the question of the position of cranks relatively to one another.

The rule is more simple than that issued by the Board of Trade, which, for the purpose of comparison, we append, but it seems to have no more theory about it than the "rule of thumb," which very closely agrees with marine practice, for the diameter of triple-expansion engine crank shafts, viz. : Add the diameters of the three cylinders in inches, and divide by three. To the quotient thus obtained add the stroke in inches, and divide this by the constant 7.

Perhaps some of our numerous readers would like to give their opinions on the practicability of the rule.

Board of Trade Formulæ for Shafting.

For compound condensing engines with two or more cylinders, when the cranks are not overhung :

$$S = \sqrt[3]{\frac{C \times P \times D^2}{f\left(2 + \frac{D^2}{d^2}\right)}}$$

$$P = \frac{f \times S^3}{C \times D^2}\left(2 + \frac{D^2}{d^2}\right).$$

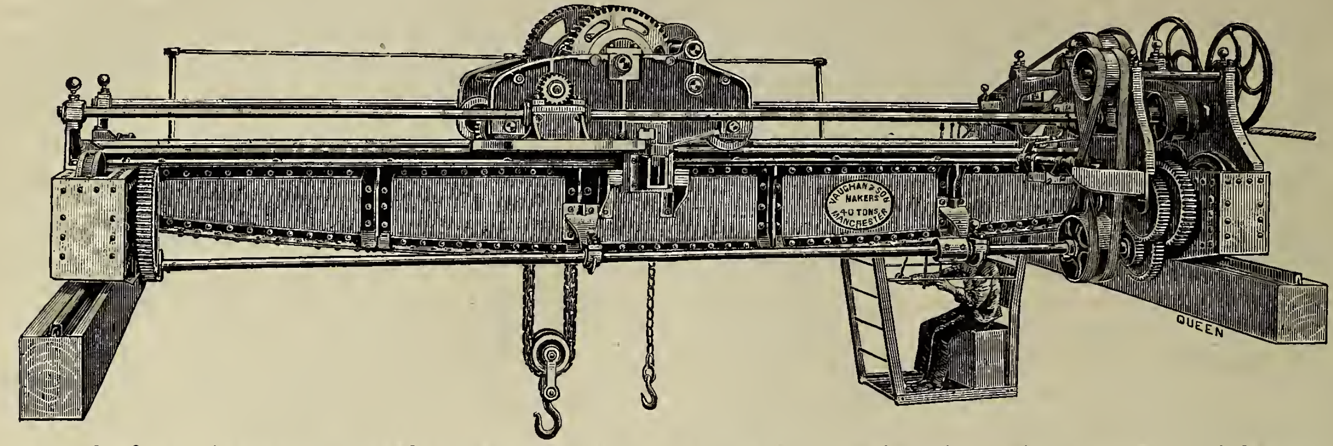
S = diameter of shaft in inches.
d^2 = square of diameter of high-pressure cylinder in inches, or sum of squares of diameter when there are two or more high-pressure cylinders.
D^2 = square of diameter of low-pressure cylinders in inches or sum of squares of diameters when there are two or more low-pressure cylinders.
P = absolute pressure in lbs. per square inch.
c = length of crank in inches.
f = constant from following table.

Note.—Intermediate pressure cylinders do not appear in the formulæ.

Table.

For two Cranks, Angle between Cranks.	For Crank and Propeller Shafts.		For Tunnel Shafts.
90°	For Paddle Engines of ordinary type, multiply constant in this column 1 suitable for angle of cranks by 1·4.	1047	1221
100°		966	1128
110°		904	1055
120°		855	997
130°		817	953
140°		788	919
150°		766	894
160°		751	877
170°		743	867
180°		740	864
For 3 cranks at 120°		1110	1295
For 1 crank		740	864

PATENT ROPE-POWER OVERHEAD TRAVELLING CRANE.



The overhead travelling crane illustrated above, constructed by Messrs. Vaughan and Son, Manchester, possesses several novel features which render it a specially convenient tool for engineers and others engaged in the rapid and accurate handling of heavy weights. The girders carrying the crab are constructed of wrought-iron or steel plates strongly stiffened and fastened together, and firmly united to the wheel boxes at each end. The crab, which runs on four wheels, is fitted with two barrels, the smaller of which is furnished with a single chain and swivel hook for lifting weights at a quick speed. The larger barrel for raising the heaviest weights is filled with two spiral grooves for the chain, starting at the centre and running right and left hand respectively, and the middle of the chain, after being threaded through the sheave, is looped up to the suspension bar of the crab; so that by this means the raising and lowering of the weight is always effected in a true vertical line, a point which is frequently of considerable importance, especially in foundry work, as in lifting the copes of moulds, lowering coves into place, or drawing patterns, &c.

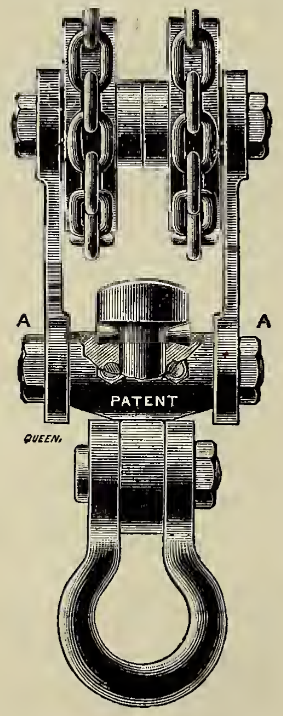


Fig. 1.

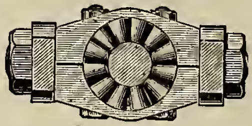


Fig. 2.

For foundry purposes a special arrangement of the driving headstock is also adopted for affording a very slow hoisting motion, so that for convenience in drawing patterns out of the sand a speed as low as one foot per minute can be obtained, and a quick motion can be instantly applied when desired. Another point which will be much appreciated where the raising and lowering of a weight in a vertical plane is a desideratum is the arrangement of the hoisting shackle, shown in detail in figs. 1 and 2. The bearing of the collar forming the head of the hook consists of a number of conical rollers, so that the load can be resolved round the vertical axis with ease, and fixed in any desired position without causing twisting in the chain or necessitating steadying by hand.

Power is conveyed to the crane by an endless cotton rope, running at an average speed of 2,000 feet per minute, and a special feature in connection with the crane is that the lowering speeds of both barrels are about 60 per cent quicker than the hoisting speeds. The workmanship and finish of the crane throughout are first class. The whole of the axles and shafts are of steel, and run, in almost every case, in gun-metal bearings, which as far as possible are made adjustable. The attendant, owing to his position, has a full and uninterrupted view of the work in hand, and by means of levers can put all the shafts in motion at once; in other words, he can travel along the shop, move the crab along the crane, and hoist or lower all at once; while the various movements can be executed independently, if desired. The cranes are constructed to lift any weight up to 100 tons, and of any span up to 100 feet.

NEW AMERICAN STEAMER.

Another new steamer, the City of New York, has been added to the fleet of fine vessels already possessed by the Inman Company, and running across the Atlantic between New York and Liverpool. The vessel has already arrived at Liverpool, and is to commence running on the 1st of August. The performance will be watched with much interest, as she is the first Atlantic liner that has been fitted with a twin screw, and has ventured to rely exclusively on forced draught for producing the requisite quantity of steam.

The vessel measures 560ft. in length, 63¼ft. in breadth, and 42ft. in moulded depth. On her trial trip she had a draught of a little over 23ft., which is stated to be one foot less than her draught when crossing the Atlantic, and which will give a total displacement of nearly 15,000 tons. She is designed to carry 1,350 passengers, of whom 550 would be first-class. The accommodation is of a palatial character. The saloon, which is calculated to dine 200 people at once, measures 100ft. in length by 50ft. in breadth, and is lighted by a lofty arch of painted glass running for half its length at a height of 20ft. from the floor. The decoration is of the most elaborate and tasteful description, and the electric light is used throughout.

The boilers, which are nine in number, and worked at a pressure of 160lb. on the inch, have each six furnaces, affording a total firegrate surface of 1,250 square feet. This, however, large as it is, would be insufficient to enable the vessel to achieve the requisite speed without the use of the forced draught, and they are worked on the plenum or closed stokehole system, the air being forced in by blowers and maintained at a pressure equivalent to a head of about ¾in. of water.

The engines are the triple-expansion type, the diameter of the high-pressure cylinder being 45in., the intermediate 74in., and the low-pressure 113in. On the trial trip, diagrams showed the initial pressure to be in the first cylinder, 148lb., in the second 74lb., and in the third 13lb. The stroke of the engines is 5ft., and the revolution of the screws 84 per minute. The diameter of the screws, it may be stated, is 20ft., and the pitch 28ft., while each screw has three blades.

At her run on the measured mile, the vessel realised a speed of 19·7 knots on the first run, and 20·2 knots on the second, the engines developing 18,500 H.P.

It is estimated the coal consumption of the vessel in crossing the Atlantic will probably exceed 300 tons per day, and whether forced draught and the twin screw are the most economical methods of utilising this enormous expenditure of fuel is a question that the behaviour of the vessel will materially assist in determining.

LESSONS IN MECHANICAL DRAWING.—XIX.

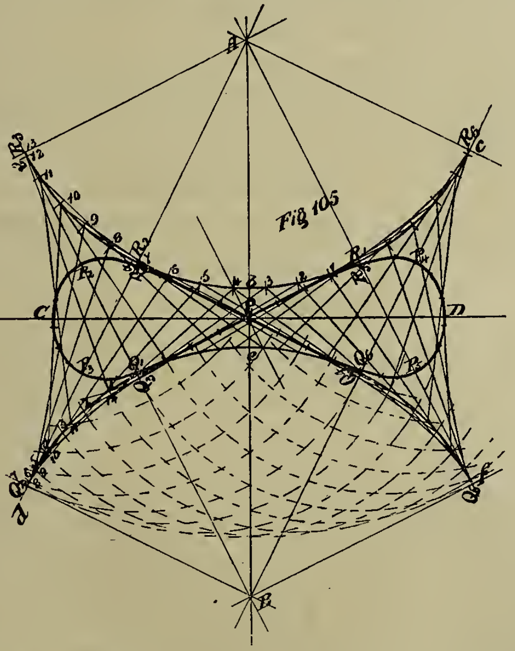
By Prof. A. MacLay, B.Sc., C.E.

POINT PATHS.—*(continued.)*

Ex. 92, Figs. 103, 104, and 105.—To show the path of a point on a line, when the extremities of the line are constrained to move in different paths. For simplicity let the describing point be the middle point of the line.

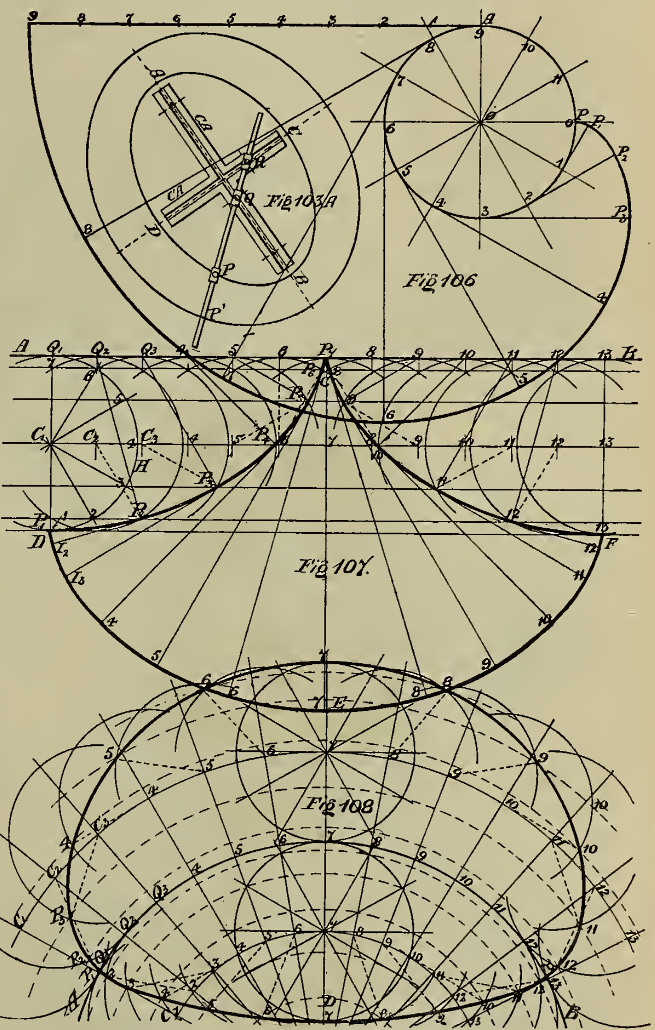
(*c*) Fig. 105.—When the extremities are constrained to move in circular arcs.

In fig. 105 the paths of the extremities of the line are arcs of equal radius, placed at a short distance apart, and while the extremities of the given line move along these, its middle point describes a double-looped curve, resembling the figure 8. Let A and B, two points 6in. apart, be the centres of two arcs of circles *a b c*, and *d e f* of 2½in. radius. Further, let the line QR, whose extremities are to move along these arcs, be equal in length to their common tangent, and let P, the point whose path is to be traced, be as before the middle point of the line QR. The central position of P will, of course, be situated on the line of centres AB and midway between A and B, viz., at the point P_1. Also, the central positions of the line QR will be the tangents Q_1R_1, Q_4R_4, through P_1, to the arcs *a b c* and *d e f*, and the extreme positions of the line QR will coincide with the tangents to the arcs through their centres A and B, viz., Q_3R_3, Q_2R_2, Q_6R_6, and Q_5R_5, the corresponding positions of P being at P_2, P_3, P_4, and P_5. The extreme positions of P are at the points C and D on the line CD, the perpendicular to AB through its middle point P_1.



Construction: Draw a straight line AB, and on it mark two points, A and B, 6in. apart. With these as centres, radius 2½in., draw the arcs *a b c* and *d e f*. Bisect AB at P_1. Through P_1 draw CD a perpendicular to AB, and tangents Q_1R_1, Q_4R_4 to the arcs. (Ex. 46, Fig. 60, lesson X.) From centre A draw Ad_1, Af, tangents to the arc *d e f* (Ex. 45, fig. 58), and from centre B draw Ba_1, Bc to the arc *a b c*. By joining the points Q_1R_1, Q_4R_4, we show the middle positions, and by joining the points Q_3R_3, Q_2R_2, Q_6R_6, and Q_5R_5, the extreme positions of QR in its range of motion. By bisecting each of these lines the corresponding position of P is determined.

For the intermediate positions of the line, take a number of points on the one arc, and with these as centres, radius QR, cut the other arc. Thus on arc *a b c* take a number of points 1, 2, 3, &c., as successive positions of R, and with these as centres, radius QR cut the arc *d e f* at 1, 2, 3, &c., for the corresponding positions of Q. Thus, beginning with R at position R_1, Q is then at Q_1 and P at P_1, the intersection of AB and CD. Supposing the line to begin to move from that towards the left hand, R moves along the arc from R_1 through R_2 to R_3, its extreme position, while Q moves from Q_1 to Q_2 at *d* and back again to Q_3. When Q reaches Q_4, then R is at R_4 and P has returned to its middle position, as at first, having traced out the left-hand loop of the curve. During the second half of the motion Q moves from Q_4 to Q_5, its extreme position, and back to Q_1, while R has passed from R_4 through R_5 to R_6, and back to R_1, and P has traced out the right-hand loop and thus completed the figure.



By making the construction follow these movements, the student will find no difficulty in tracing the curve of P's motion. (Notice that the middle portions of the path are straight lines—a fact which was ingeniously taken advantage of by Watt in his Parallel Motion.)

Ex. 93, Figs. 106, 107.—To draw the path of the extremity of a flexible inextensible line, which is made to unwind itself tangentially from some curved surface, in a plane at right angles to its axis.

The path or curve so drawn is termed the "involute" of the surface, or rather of the plane section of the surface, and the plane section is termed the "evolute" of the curve.

Let us take two examples, viz., when the evolute is—
(*a*) a circle; (*b*) cycloid.

(*a*) In fig. 106 the evolute is a circle of 2in. diameter, and the curve shown is the involute of a circle, more commonly referred to simply as an involute. From the conditions it follows that if a line be drawn from any point on the curve tangentially to the circle, the length of the tangent must be equal to the circumferential distance from the tangent point to the initial point of the curve. Thus in fig. 106 a line drawn from P_3 tangentially to the circle at point 3 on its circumference is equal in length to the arc 30.

Construction: With any point O as centre, and a radius 1in., describe a circle. Divide its circumference into a number of equal parts, say 12, and at each point of division draw tangents, each one longer than the last by the arc distance of one division. This may be done by stepping off as accurately as possible the length of one arc division along the first tangent, and by doubling this distance for the next tangent, trebling it for the third, and so on. This, however, has the disadvantage of multiplying any slight error in the length first determined. A more exact way is to lay off a length equal to the circumference of the circle, say along one of the tangents—*e.g.*, that through the initial point of the curve—and to divide it into as many equal parts as we have previously divided the circumference of the circle.

In fig. 106 space only permitted three-fourths of the curve to be shown. Along the tangent at point 9 on the circumference of the circle a length equal to three-fourths of the circumference is marked off, and divided into 9 equal parts. With distances A1, A2, A3, &c., of this line, lengths are cut off on the tangents to points 1, 2, 3, &c., respectively on the circumference, to find the points 1, 2, 3, &c., on the path, and a curve is drawn through them.

(*b*) In fig. 107, the evolute is a cycloid. The lower curve DEF is the involute of the upper curves DC and CF. The construction cannot be properly understood until the student has drawn the cycloid itself, which forms the subject of the next case taken up. (See next exercise, after working which, and having drawn the cycloid, return to the present problem and draw its involute.)

The tangent at any given point on a cycloid is formed by first drawing the "normal," or perpendicular to the curve at that point. By one of the properties of the cycloid, this is the line from the point to the contact point between the describing circle and its base line. The tangent is drawn at right angles to this. Thus the normal at P_2, fig. 107, is the line P_2Q_2, and the tangent is P_2I_2. Next, to find the length of the tangent P_2I_2. Take a distance which is a small fraction of the arc P_1P_2, and with this step off a length on the tangent equal to that of the arc. Along the tangent, at P_3, step off similarly a length equal to the arc P_2P_3, and add to it P_2I_2. In the same way, proceed to find all the points on the cycloidal path DEF, and draw a curve through them.

Ex. 94, Figs. 107, 108.—To draw the path of a point which is situated on the circumference of a rolling circle. When the circle rolls (*a*) upon a straight line, (*b*) upon a circle, (*c*) under a circle.

(*a*) In fig. 107, AHD is the given rolling circle, with centre at C_1 and P_1 is the given point on it. AB is the line on which the circle rolls, and DCF is the path of P. When Q, the point of contact, goes forward from Q_1 to Q_2Q_3, &c., P advances from P_1 to P_2, P_3, &c. When the point of contact has moved forward a distance equal to the half circumference of the rolling circle, P reaches the line AB at P_7, from which, during the second half of the motion, it passes through P_8, P_9, &c., to F.

Construction: Draw the line AB, and describe a circle of 2in. diam. in contact with it. On AB mark off a distance Q_1 13, equal to the circumference of the rolling circle. Divide the circumference and this distance into the same number of equal parts, say 12. Through the parts in the circumference draw parallels to AB, and through the points on AB draw perpendiculars to it, to cut the line of centres at the points C_1, C_2, C_3, &c. Then from C_1, the centre corresponding to the point of contact Q_1, with radius 1in., cut the parallel through point 1 on the circle to find P_1, the first position of P. Repeat the same for the next set of points; centre C_2, contact point Q_2, with same radius cut line through point 2 on the circle for point P_2 on the path. Follow out in the same manner the points P_3, P_4, P_5, &c., and draw the cycloidal path shown in fig. 107.

(*b*) In fig. 108, the describing circle rolls upon a circle. The construction is exactly similar to the last, the modifications being an arc AB, instead of the straight line base AB in fig. 107, concentric circles for the parallels through the points on the circumference of the generating circle, and radial lines for the perpendiculars to the point of contact. The points of contact are Q_1, Q_2, Q_3, &c., the centres C_1, C_2, C_3, &c., and the corresponding points on the curve are P_1, P_2, P_3, &c.

(*c*) When the circle rolls under a circle. This curve forms a continuation of the last. The points of contact are the same, and the centres are on the same radial lines continued below the arc AB, while the point P describes the curve $P_{13}DP_1$ below the arc.

Curve *a* is called a "cycloid," *b* an "epicycloid" [επι, (*epi*) upon], *c* a "hypocycloid" [υπο, (*hypo*) under], curves which, along with that in fig. 106, have important applications in connection with the teeth of wheels.

MACHINERY FOR THE STEELWORKS AT TERNI.—III.

(Concluded from page 340.)

CRANE FOR STEAM HAMMER.

Powerful lifting apparatus has been provided for working with the hammer, in the shape of two large radial jib cranes, capable of dealing with weights of from 100 to 150 tons. Each crane consists of a swinging arm or bridge revolving around a pivot carried by the frame of the hammer, and carried at its outer end by a large triangular support, borne on two four-wheeled trucks. These trucks run on a circular railway 131ft. in diameter. The cranes can describe a complete circle round the hammer. They are provided with the necessary motions for travelling on the railway, lifting the ingots, carrying them backwards and forwards between the hammer and the furnaces, and giving them the necessary rotary motion while under the action of the hammer. All these motions are performed by engines placed on the working platform. The great height of these cranes is an unusual particularity, the crabs being carried at a height of about 75ft. from the ground. This is a necessary consequence of the disposition adopted, as the crab must be brought as near as possible to the pivot, in order to allow of the ingot suspended from it being brought well under the hammer. The pivot around which the arms of the crane revolve is double, consisting of two hollow cast-steel cylinders turning one within the other on a steel step, the internal cylinder being of greater height than the external one. Each cylinder is cast with a flange, to which is bolted an angle iron, forming the lower edge of a kind of semi-cylindrical loop, terminating the radial arm of each crane, the whole forming a large hinge joint between the frame of the hammer and the crane girders. With this arrangement the nearest approach of the overhead crabs to the centre of rotation corresponds to a distance between centres of 69in.

Although the two cranes are made for different loads, they are precisely similar in most details; in fact, all the smaller parts are of the same pattern for both cranes. What difference exists between the two consists mainly in the less heavy construction of the frame and girders of the 100-ton crane, and inferior power of the gearing. The motive power is the same in both cases, being supplied by two double-cylinder compressed-air engines, with cylinders 7·8in. in diameter and 12in. stroke, running at a maximum speed of 200 revolutions per minute. The air, at a pressure of 90lb., is fed to these engines by a small pipe branching off from the main supply pipe for the hammer, and fitted with a swivel joint, whence branches are led off to the engines on both sides.

Each engine is provided with a reversing link and a small flywheel. For lifting weights they drive, by means of a train of bevelled wheels, two large endless screws, gearing with two spur wheels keyed on to the axles of the winch drums. As these screws transmit considerable power, the shaft on which they are cut is made with collars, and works in a thrust-block. The thrust-block has subsequently been lengthened and made to carry a brake pulley, the brake being put on by an air cylinder.

The winding chains pass from the drums over two large guide pulleys, mounted on brackets overhanging the rear of the cranes; they are then brought parallel to each other by running round two horizontal pulleys, and engage in the grooves of the two large pulley blocks carried by the traveller. Each of these blocks has, in the larger crane, four, and in the smaller one, three sheaves. The chain used is made of iron 1⅝in. in diameter. The two hanging blocks are provided each with a spring carrier, on to which is hooked a large chain made of 2½in. iron. This chain is passed round the ingot to be raised.

The traveller is worked backwards by pitch chains, one on each side, running over spur wheels placed at the extreme limits of the travel, and to which motion is given by bevel wheels carried on the same shaft. The bevel wheels are driven from the engines below by a vertical shaft, supported by carriers at intermediate points of its height. Two shafts are actually provided, and both engines can be used for this motion.

As already mentioned, the large A-shaped frames of the cranes are each carried on two four-wheeled trucks. A kind of large ball-and-socket joint has been interposed between the A frames and the trucks, to allow of the load being fairly transmitted to both trucks under all circumstances, and counteract the effects of any defects in the laying of the circular railway. A further advantage resulting from this arrangement is the facility it affords for the erection of the cranes.

The axles of the trucks are, of course, radial, and the inner wheels of less diameter than the outer ones. One of the inner wheels in each truck has a false rim bolted on to it, this rim being geared to receive a pitch chain, by means of which it is driven from a pinion on a lay shaft carried in bearings on the truck. Motion is communicated to this shaft by bevel wheels and a vertical shaft descending from the working platform, and held below by a side bearing fixed to the frame of the truck. It is found sufficient to act on a single wheel of each truck. The wheels are of cast iron, with steel tires and axles, these last having a diameter of 9¼in. in the journals.

Blowing Engines.

Like all other engines in use at Terni, these are driven by water power. The prime motor is a large turbine.

The blowing engine is of the horizontal type. It is made of sufficient dimensions to maintain an effective pressure of 30lb. per square inch in the converter. This pressure is maintained with a speed of 40 revolutions per minute, that of the turbine being 200 revolutions, reduced by gearing with a ratio of 5 to 1. The cylinders are 49in. in diameter, the stroke being 59in. Each cylinder is surrounded by a sheet-iron jacket, through which water is circulated, so as to prevent any undue heating of the air. The inlet valves are of very simple construction, being plain brass disks with a leather face, fitted on to a guided spindle. At the return stroke of the piston a spiral spring, acting on to the head of the spindle, brings the valves back on to their seats. The engine works at a speed of three revolutions per minute.

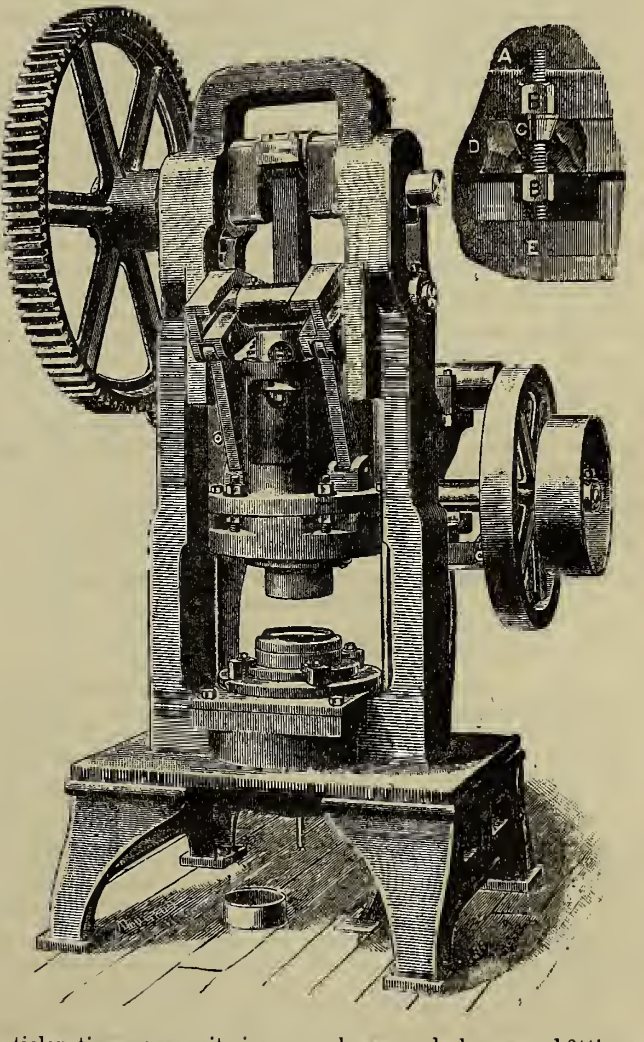
For the exhaust valves, which are exposed to a much higher temperature, no leather, indiarubber, or other organic substance can be made use of for any length of time, and the best results have hitherto been obtained with flat cast-iron F valves, having a rounded edge, and working on a plain spindle. These exhaust valves are all placed on the upper part of the cylinder. When closed, contact is maintained simply by the weight of the valve and the air pressure from above. Like the large valves for working the 100-ton hammer, their contact surfaces are reduced to a mere line, so as to open with the least possible effort.

THE STILES NEW TOGGLE-JOINT DRAWING PRESS.

The accompanying illustration, taken from the *American Machinist*, shows a press for drawing sheet metal, recently brought out by the Stiles and Parker Press Co., Middletown, Conn.

In designing this press, the plan formerly pursued of employing cams upon the crankshaft for the purpose of forcing down and holding the blank-holder has been abandoned, and in its place a toggle-joint movement is used, which is so constructed that when the pressure of the blank-holder is fully brought on to the blank, all strain due to that pressure is taken off the crankshaft, and transferred to parts composing the toggle mechanism, all the working parts of which, as soon as the full pressure is attained, cease their motion and remain at rest during the "dwell" of the blank-holder, and are consequently not subjected to the wear and tear which inevitably result from any movement of the working parts under such tremendous pressure as is necessary to hold a large blank while being drawn.

For the benefit of those not familiar with this class of machinery, it may be interesting to state that it is with such machines that the numerous forms of hollow sheet metal-ware and ornamental articles, tinware, granite ironware, brass goods, lamps and fittings, clock cases, silver and britannia ware, &c., are drawn and pressed into shape without joints or seams from the flat sheets of the material. It is by the use of such machines, probably more than any other one cause, that such goods are produced with such marvellous exactness and elegance of form, and at such low cost.



It will be noticed by reference to the engraving that there are two slides or plungers, one working within the other. The outer one is called the blank-holder, its purpose being to first descend and press the outer portion of the blank firmly to the face of the die, and it then remains stationary, exerting a heavy pressure upon the blank, while the inner plunger or punch descends and presses the centre of the blank into the die, forming the shape desired.

Heretofore the practice has been to employ cams upon the crankshaft which gave motion to and caused the pressure upon the blank-holder, and to afterward raise it by the action of a spring, a counter-weight, or similar device, but this method was found to be open in practice to several serious objections.

In designing the press here shown, the object has been to avoid the difficulties attending the use of cams, and produce a press in which as little wear and yielding under pressure shall take place as possible, and to so arrange that what wear does take place shall have the least possible injurious effect upon the action of the machine.

Upon the upper part of the plunger are two rollers, one on each side, which work in the cam tracks formed in the upper members of the toggle joint. These cam tracks are so formed that when the plunger starts to descend, by the action of the crank and connecting rod, the blank-holder is made to descend ahead of it until it presses upon the blank with the required pressure ; at this time the toggle joints are straightened, their three working centres being in the same vertical line, and at the same time the lower portion of the cam track is in a vertical line and parallel to the motion of the plunger, so that there is no further motion of the toggles, and little or no strain upon the rollers or cam tracks, the strain arising from the pressure put upon the blank having been transferred to the members and pins of the toggle joints and the frame of the machine, none of the parts under this strain being in motion during the "dwell" of the blank-holder.

It will also be noticed that the slides of the blank-holder and of the plunger, the dye in which the work is done, the upper and lower centres of the toggle joints, and of the crankshaft are in the same straight line, thus avoiding all tendency to "cramp" the slides and produce side strains, and also that the main frame, which must resist these strains, follows the same straight line, thereby securing the greatest possible rigidity.

Another feature of importance is the manner of adjusting the blank-holder so as to bear evenly all round the blank, without the necessity for "packing" the dies. For this purpose the blank-holder plate proper (E in the small cut) is supported by three or four large screws, which can be adjusted separately, without any tendency to cramp the movement of the slide in its bearings. The conical split nuts, C, adjust themselves to any angularity in the position of the screws which may become necessary in order to produce an even pressure all around.

These presses are made in fourteen sizes, weighing from 1,000lb. to 60,000lb., the smaller sizes as flywheel presses, the larger ones geared like the one shown.

CORRESPONDENCE.

We do not hold ourselves responsible for the opinions of our Correspondents.

EVAPORATIVE TESTS.

To the Editor of "The Practical Engineer."

Sir,—Your article on page 349 will no doubt be read with interest by many of your readers, and may perhaps be a means of inducing many (who have the opportunity) to test their boilers and find out the actual efficiency of the fuel they are using, and the conditions of working most suitable for the different qualities and quantities to be consumed. For instance, it is well known that with large fires and good draught a much poorer class of fuel can be used than in small fires; hence the superiority of 8ft. boilers over 6ft. 6in. boilers; for, so long as the fire is not too large to be under the control of the stoker, it is not too large to give economical results, either by using cheaper fuel, or best fuel and less of it. But where the boiler is small and the area of firegrate restricted, good coal must be used to give good results.

The portion of the article on which you might have enlarged or given fuller information is that of reducing to a standard "at and from 212°." I have carried out several tests, and had occasion to reduce to this standard, either by the formula given by D. K. Clark (page 768 "Manual of Rules, Tables, &c."), or from Rankine ("The Steam Engine," page 254), or from Wilson (page 307 "Treatise on Steam Boilers"), each of which gives a slightly different result. Therefore I take this opportunity of asking you, or any of your very practical readers, to explain which is the correct method. Wilson's is perhaps only an approximate method, but the difference may be inappreciable, while the formula is easily remembered ; but not so with Clark, as it is not easy to see why he adds 32° in each case to H and H^1, which he says represents total heat from 32° F. Rankine is much more complicated and difficult to see through, for though I have several times used his formula, I must still acknowledge my ignorance as to his reasoning. Where does he get the quantity 0·3, and why does he use it?

I feel sure, sir, if you would give a short or correct way of arriving at this "standard," or explain Rankine's formula, you would confer a boon on many, as well as yours obediently, Scriber.

Salford, July 28th, 1888.

DEFECTIVE VALVE DESIGN.

To the Editor of "The Practical Engineer."

Sir,—I have read with interest your article on defective valve design, which I think will be interesting to many readers of your valuable paper. With respect to compound engines running with cranks at right angles, I quite agree with you that many enginemen would say the diagrams shewn in fig. 1 were caused by the steam valve closing in the low-pressure engine, but you have shown plainly that in this case it was the fault of the valve. I have no doubt that many engines are working under the same malformation of valve, but at the same time it is possible to produce very similar diagrams to those in question with valves well designed, owing to the setting of low-pressure valves. In going through the particulars given of the valve and ports, I find with a traverse of $8\frac{1}{2}$in. the steam would be cut off about three-fourths of the stroke, and with a traverse of $6\frac{1}{2}$in. a little before half-stroke, or one-fourth of the stroke sooner than with the $8\frac{1}{2}$in. traverse. In looking over the diagrams I find very little difference, except that the back pressure is reduced 9lb. for a very short portion of the stroke, and if we look at the two first divisions at each end of the diagrams, we shall find the back pressure rather lower in fig. 1 before altering the traverse than in fig. 2, after the alteration. On examining fig. 3, I notice another point which is not referred to in your article. If you assume the traverse to be $8\frac{1}{2}$in., and take the dimensions given, you will find that when the valve is at full throw it uncovers the exhaust port seven-sixteenths of an inch, thus letting live steam out of the valve box into the exhaust port between the two cylinders, which I think is a great evil, and liable to alter both the high and low pressure diagrams either with the cranks at right angles or otherwise in compound engines ; therefore, if you could publish the low-pressure diagrams before and after alteration of traverse of valve, it would, I think, be interesting to many of your readers.—Yours truly, Right-Angle.

To the Editor of "The Practical Engineer."

Sir,—I have read with much interest the articles on valve gearing which have appeared in your excellent journal. I shall be glad if the writer of the article entitled "Defective Valve Design" will kindly inform me how he manages to increase the initial pressure of steam from $68\frac{1}{2}$lb. and 71lb. to $69\frac{1}{2}$lb. and $74\frac{1}{2}$lb. respectively, by *reducing the port opening* from 2in. to $1\frac{1}{16}$in., as I should have expected quite an opposite result. Also, what is the object of the $\frac{9}{16}$in. negative lap on the exhaust side, which will have the effect of opening both ends of the cylinder at once to the exhaust? I notice that with $4\frac{1}{4}$in. throw, the exhaust would not only be locked in the cylinder, but the exhaust port would also be opened $\frac{9}{16}$in. to the live steam when the valve is at the end of its stroke.—Yours, &c., Valve Gear.

July 31, 1888.

IMPAIRED VACUUM.

To the Editor of "The Practical Engineer."

Sir,—In your issue of the 6th inst., writing on the above subject, "Mechanical Engineer" says that I labour under a very erroneous but common impression—that if the pressure on the piston is much below the boiler pressure there is something wrong. But he attributes it to the governors doing their work all right, and that it does not require more than 70lb. to do the work. If our steam runs down from 100lb. by gauge to 80lb., the engine will not do its work ; so that cannot be the cause. I am very thankful to "M. E." for his notes on the "Loss of Vacuum," but have not found any leakage as yet to destroy it. I may mention that our engine is worked by double-beat valves.—Yours, &c.,

July 30. Young Engineer.

STAYING FOR LANCASHIRE BOILER.

To the Editor of "The Practical Engineer."

Sir,—With your permission I should like to refer to your article on staying of the above, in your last issue. Anyone who has examined many boilers by many makers must have had occasion frequently to bemoan the slipshod way in which even the best firms sometimes fit the stays in Lancashire and Cornish boilers. It is no uncommon thing to find the angle bars from $\frac{1}{8}$in. to $\frac{1}{2}$in. wide for the gusset plates, and with rivets loose enough to shake with the fingers after a few months' work. With such examples in mind, I would be very unwilling to specify gusset stays other than radial. If the stays are fixed as shown on page 354, there is the advantage gained of equal distribution on the end plate, with equal division on the shell circumference ; but there is the disadvantage of additional work, or, which is quite as likely, scamped work, for either the gusset plates must be bent, or each angle bar must be set, one to less and one to greater than a right angle. Of course, angle bars might be rolled to the required angles, but that is not done, and the consequence is they are fitted wide, and the rivets, instead of being in double shear, are subjected to a bending strain by which they are gradually loosened. By increasing the distance by about $2\frac{1}{2}$in. between the centre stay and the next on each side, and leaving the outer ones as shown, equal distribution on the end plate is obtained with radially-set stays. The result is not less pleasing to the eye ; the plates are straight, and the angle bars *should* be close—at least there would be no excuse for their not being so.

Your remark about longitudinal bolt stays being simply "sentinels" is quite called for, but instead of being put in as a stand-by, they are frequently fitted as if *all* depended upon them, and the gusset stays are as frequently fitted as if *nothing* depended upon them whatever. Referring to paragraph on stays in specification, page 356, the breadth of the gusset plates is not given. I dare say it may be considered superfluous to fix such details, but in point of fact it is absolutely necessary, for many firms, who from their standing in the trade, the tools they possess, and their competing with the foremost, may consider themselves *leading* firms, actually get the gusset plates in by the manhole after the ends are riveted on, thus limiting the plate breadth to 15in. It is common enough, for instance, to find the centre stay of a 7ft. 6in. diameter boiler with 10 rivets in each angle bar—that is, 20 rivets to the end plate, and 20 rivets to the shell plate, and only five or six rivets through each end of the gusset plate; in fact, they are not gusset plates, they are parallel plates of from 14in. to 16in. broad at the very most.

I am aware that this is not the usual practice in the "home" of the "Lancashire" boiler, but until recently it was very much the practice in the "provinces," and as if to make such stays as useless as possible, they are frequently fixed to the first belt of the shell plates. In these days of keen competition, when even the least saving in labour or material counts, everything of any importance should be detailed in a specification; otherwise he who offers a well-designed boiler is handicapped by the ignorant competitor. Let me conclude by expressing the hope that *The Practical Engineer* will meet with all the success it deserves. I consider that it fills a long-felt want to those who are interested in land boiler and engine practice.—Yours faithfully,

July 31, 1888. SAFETY.

[*In consequence of pressure of space several letters are unavoidably held over.*]

QUERIES AND REPLIES.

COST OF OCEAN CARRIAGE.—Can any reader inform me what is about the average expenditure of fuel in steamships per ton of cargo per mile? I have an impression the quantity is very small, but cannot say precisely.—CARGO.

Answer.—The expenditure of fuel will depend not only on the distance, but also on the velocity; that is to say, the same ship with the same cargo would require a higher expenditure of fuel per mile run when going at a fast speed than at a slow one. Some engines are also more economical than others in consequence of their better design. You may take it, however, in round figures, that in a well-designed steamship, with all modern improvements, such as triple expansion, forced draught, &c., 100 tons of cargo can be moved at a speed of 10 knots an hour for a cost of about 1d. per mile.—ED.

STONE-WORKING MACHINERY.—Can any reader tell me the address of Messrs. Brunton and Trier, makers of stone-working machinery?—G. H.

Answer.—Messrs. Brunton and Trier have, or had a short time ago, a work-at Brighouse, Yorkshire.—CHALKLINE.

Answer.—The address of Brunton and Trier, the stone-dressing machinery manufacturers, is 19, Great George Street, Westminster, S.W.—QUARRY.

POWER OF WATERWHEELS.—On page 234 of "The Modernised Templeton," by Hutton, the following rule is given with regard to the power of waterwheels:—

"The effective power is equal to the product of the number of cubic feet and velocity of wheel in feet per minute multiplied into ·001325."

Applying this rule to the case of a fall, 25ft. in height, and over which 112 cubic feet are delivered per minute, the book gives the result as follows, the velocity of the wheel being 10ft. per second:—

$$112 \times 10 \times 60 \times \cdot001325 = 89 \text{ H.P.}$$

Now the total energy in the falling stream of water only equals

$$112 \times 62\cdot5 \times 25 = 175{,}000 \text{ foot pounds per minute,}$$

$$\text{and } \frac{175{,}000}{33{,}000} = 5\tfrac{10}{33} \text{ H.P.}$$

Will some one kindly explain to me whether am right in the above reasoning, and if I am, in what way the rule given in "Templeton" is useful.

Answer.—The rule you have quoted from "Templeton" is altogether wrong and misleading. The total energy of the fall cannot exceed $5\frac{10}{33}$ H.P., and the adoption of any mechanical device would make the power obtained less than this. It would, of course, be possible to devise a formula for the power of a wheel based on its velocity and the quantity of water used, but even then the power would be a function of the *square* of the velocity, and not of the velocity *simply*, as given in the rule. If the other rules in Hutton's "Modernised Templeton" pay no greater regard to mechanical principles than the one you quote, we should advise you and any other reader to be very careful in relying upon it in working out any designs, or otherwise it may lead to some serious blunders.—ED.

MACHINE FOR STAMPING NAILS.—Will one of your readers give me the name of a good firm to manufacture a special press for stamping out nails?—F. C.

Answer.—I am acquainted with a machine of great merit for "hot forging" nails of all shapes and sizes. These nails are much superior to stamped nails. They are made to a template, and are all exactly alike of any shape or size. If "F. C." likes to communicate with me direct, I shall be happy to afford him any further information.—T. D. C.

In reply to "T. D. C.," I have to inform him that I have found a firm who have constructed the machine of which I was in quest. I fear the hot forged nails would come more expensive than the stamped samples.—F. C.

STAYING FOR LANCASHIRE BOILER.—I have read your article on "Staying for Lancashire Boiler" with much interest. I should like to know the scale for pitching the furnaces, or, in other words, what distance is the horizontal centre line of furnace from centre line of boiler's shell, and what distance is the vertical centre line of furnace from the vertical centre line of shell?—A BEGINNER.

Answer.—You can hardly have examined the sketch very carefully. The dimensions you ask for are marked on clearly in two places. They are $7\frac{1}{2}$in. and 1ft. 9in. respectively.—ED.

HAULING DRUM.—I am fitting up a drum to haul stone from a quarry 150 yards deep, with an incline of 45 deg. I have a pinion 7in. in diameter, $1\frac{1}{4}$in. pitch, on crank shaft of 10 H.P. engine, which gears in a spur wheel 2ft. in diameter. On the same shaft is another pinion 10in. in diameter, which drives the drum, 5ft. 6in. in diameter; average load 8 tons. My difficulty is with the teeth of the pinion which gears in the drum, and which keeps giving way. Is the pinion too small, or what is the cause? What would be the strongest way to replace a tooth when one gets broken?—A SUBSCRIBER.

Answer.—"A Subscriber" does not say what breadth any of his spur wheels and pinions are on the face or teeth; nor does he give us the diameter of the spur wheel on the drum shaft; nor its pitch and that of the pinion which gears with it, and which is the one that gives him the trouble by its frequent failure; so that no one can form any opinion as to the strength of his wheels or their fitness for his purpose. If he will give explicit information on the above points, I will endeavour to assist him.—W. A.

Thanks for "W. A.'s" offer of assistance. The engine is 10 H.P. On the crank shaft is keyed a pinion 7in. in diameter, $1\frac{1}{4}$in. pitch, 4in. wide, with a web each side of tooth. This gears into a spur wheel 2ft. in diameter and 3in. face of tooth, which is keyed on driving shaft. On the same shaft is a loose pinion $1\frac{5}{8}$ pitch, 3in. across face, and 10in. diameter. The brake strap forms a web on one side of this pinion, which is used for lowering the empty trollies or holding the load in shaft when the "clutch," which slides on a "feather," is thrown out of gear. This is the pinion which gives me the trouble. It gears into a segment of the drum, 5ft. 10in. diameter, $1\frac{5}{8}$ pitch, 3in. across face, the side of the drum forming a web inside the tooth. The diameter of the drum on which the wire rope coils is 4ft.—SUBSCRIBER.

LONG RAILWAY TUNNELS.—Will any of your readers be good enough to give me the names of the three longest railway tunnels in England; also state where they are and what companies they belong to.—E. L. DARNALL.

WORKING DRAWINGS.—Many thanks to "J. R." for information regarding working drawings. I quite see how the arrangement is now, but has not "J. R." made a mistake in saying the transverse distance bars pass through the bottom holes of base plate; ought it not to be through supporting strap and columns only?—CONSTANT READER.

DRAWING OF A PULLMAN CAR.—Could any reader inform me where I could get a working drawing of a Pullman car and a railway carriage?—E. P. S.

RIVET FURNACE.—Can any reader of your valuable paper give me some idea of an economical rivet-heating furnace for two stationary riveting machines?—P. H.

SMOKE-CONSUMING FURNACE.—Can any of your readers give me the address of the makers of Thompson's smoke-consuming furnace?—J. E.

SETTING CORLISS VALVES.—Would you, or any of your readers, inform me of the method of setting the above, as made by Ralph Ogden, of Ashton-under-Lyne? A description of the above engine appeared in your issue of May 6, 1887.—CORLISS.

BOOK ON DIFFERENTIAL WHEELS.—Can any reader inform me where I can obtain a copy of a book on wheels which was published by a Mr. White in the early part of the present century? The writer, I believe, was awarded a medal by Napoleon I. for a peculiar arrangement of differential gear designed by him, and which forms the leading illustration in the book. I mention this fact as it may assist in identifying the book, and I am not quite sure about its title or the spelling of the name.—DIFFERENTIAL.

BLISTERS IN FURNACE PLATES.—Would any of the readers of *The Practical Engineer* be so kind as to tell me the cause of a blister which sometimes comes in corrugated furnaces of marine boilers. I have seen new ones after only one trip go the same way, which was thought to be unsafe, and new ones had to be put in in their places.—FLYING CHILDERS.

CEMENT FOR BRASS.—Will you or some of your numerous readers kindly give me a recipe for or the name of the best manufactured cement for brass? I want to attach brass rings to the outside of a brass cylinder by means of cement.—MARINE.

REPAIRS TO WATERWHEEL.—Can any of your readers inform me how to put a segment on a waterwheel, and three pieces of the shrouds, and true the wheel? It is an iron wheel, with iron arms and cutters. Is there any book on this subject?—ONE IN A FIX.

TO CORRESPONDENTS.

TYPEWRITER AND PHONOGRAPH.—In reply to "Sceptic," we beg to say that the statement in the short article which appeared last week with regard to the speed of the typewriter was a mistake. It should have been 60 words a minute, not 600, as stated in the article.

MECHANICAL ENGINEERING.—In answer to "J. Siddall," before we could be of any assistance it would be necessary for you to say what branch of engineering you wished to follow. We should judge, however, that your education is very defective, and at your age it would be impossible to learn a trade. Possibly we may misunderstand you, and what you want is to become an engine attendant. If this is the case, write us again.

ENGINE CONSTANT.—In the case referred to by "Lancelot," there is no doubt a discrepancy between the diameter of cylinder given and the "constant" stated. The error had escaped our notice. The correct diameter, we believe, was a little over 77in., and if you will try this, we think you will find the "constant" to work out correctly.

REPORT OF ENGINE AND BOILER INSURANCE COMPANY.—In answer to "T. Davies," the report by Mr. Michael Longridge, noticed in our issue of the 20th ult., can be obtained, we believe, at the office of the Engine and Boiler Insurance Company, 12, King Street, Manchester. The price is 2s. 6d. We would strongly advise all who have to do with the working of boilers and engines to try and obtain a copy.

In our notice of the Remington type writer, in our last issue, we find that by a printer's error, and the introduction of a cypher, the machine was stated to be capable of printing 600 words per minute, instead of 60.

Constant Water Supply.—The Gas and Water Committee of the London Corporation have come to the conclusion that it is not expedient to take any steps for obtaining a constant supply of water to the City of London. They say that the constant supply to the parish of St. Pancras was estimated to cost the owners or occupiers at least £5 each for the requisite fittings, and that in the city, owing to its exceptional circumstances, the expense would probably be considerably more.

A Canal Across Italy.—An Italian engineer, Signor Victor Brocca, has just completed the survey of the proposed canal across Italy, the object of which is to save the very long journey round Cape Leuca. This canal would begin on the western side near Castro, on the Tyrrhenian Sea, and reach the eastern coast at Fano, on the Adriatic. Its length would be about 180 miles, and its proposed breadth 110 yards, and its depth 40 feet. For the purposes of the canal it would be necessary to drain the two lakes Bolsena and Thrasimene. The assumed cost of this gigantic undertaking is set down at 20 millions sterling.

Zalinsky's Pneumatic Gun.—A trial was made recently of the pneumatic torpedo gun built by Messrs. Cramp and Sons, of Philadelphia, for the Italian Government, at Fort Hamilton, N.Y., under the direction of Lieut. Zalinsky, which, according to report, proved an entire success. This is the largest gun of the type yet made, having a bore of 15in. and equal to throwing a shell a distance of two miles. At the trial two shots were fired at an elevation of 18° with 530lb. shells. The first shell fell at 1,200 yards, the second, with a more continued air pressure, over a mile. The full air pressure was not called into play.

An Electrical Deep-sea Sounding Instrument. — A series of experiments have recently taken place in the neighbourhood of Oban, for the purpose of testing a new patent electrical sea-sounding apparatus, by Messrs. Cooper and Wigzell, London. The invention is described as consisting of a sounder, a heavy instrument having a water-tight cavity at the upper end, which contains mechanism actuated by the pressure of the water, and at the bottom end it is fitted with jaws. These jaws close suddenly when they reach the bottom; they thus secure a specimen and bring it up. The sounding wire is wound on a strong cast-iron winch, through which the electric current passes. On the recording dial, a pointer or hand moves as the sounder descends the water, and becomes stationary on its reaching the bottom, marking on graduated cardboard the exact depth of the water.

The Iron and Steel Institute.—The autumn meeting of the Iron and Steel Institute will be held in Edinburgh during the three days commencing Wednesday, August 22nd next. An influential local committee is being formed in Edinburgh for the reception of the institute, of which the Earl of Rosebery is president. The list of papers to be read and discussed is not yet complete, but the following is a partial programme: (1) "Testing Machines," by the president; (2) "Manganese Steel," by Mr. R. A. Hadfield; (3) "The Metallurgical Exhibits at the Glasgow Exhibition," by Mr. W. J. Millar, C.E.; (4) "The Mineral Resources of the East Coast of Scotland," by Mr. Howell, Director of the Scottish Government Survey; (5) "The Forth Bridge;" (6) "The Testing of Materials of Construction in the United States," by Mr. George H. Clapp, Pittsburgh; (7) "A New Form of Pyrometer," by Professor Wiborg, Stockholm.

Decomposition of Sewage by Electricity.—At the recent annual meeting of the Association of Sanitary Engineers, Mr. William Webster, F.C.S., read a paper describing the decomposition and purification of sewage by means of electricity. He passed a strong current of electricity through sewage before the meeting, and the solid matter speedily rose to the surface, leaving the fluid apparently bright. He also exhibited a sample of effluent water, eight months old, and also a specimen of a disinfecting fluid obtained from sewage twelve months ago. The chief expense, he stated, was the engine power, and the process could be applied to any existing tanks. Several speakers considered the process likely to be productive of great results, provided it could be economically applied to the treatment of large quantities of sewage, as the analyses submitted showed the effluent water to be absolutely free from suspended matter.

Steven's Rudder Controller,—With a view to prevent catastrophes from the breakdown of steering, an ingenious rudder controller has been devised by Mr. Thomas G. Stevens, Walbrook, London. By means of this contrivance, the control of the rudder can be immediately regained in the event of a breakage of the chains or rods or any part of the apparatus now in use for steering, either by hand or by steam. It is what is known as a strap-brake, and consists of a fricton-band fitted round a disc, which is fixed on the wheel-shaft of small vessels, and on the rudder head of those of larger tonnage. The strap-brake is put on and taken off by means of a small hand-wheel actuating a right and left handed screw, the wheel being placed within easy reach of the steersman. On the turning of the hand-wheel in one direction the strap is caused to grip the periphery of the disc, and thus to put the brake on, holding the rudder in a fixed position. The apparatus is also intended to take the place of relieving tackle and to enable the helmsman to hold the rudder at any required point in heavy weather, and to release it instantly by reversing the hand-wheel.

SELECTED PATENTS.

APPLICATIONS FOR LETTERS PATENT.

July 19th.

10463 Repeating Fire-arms, W. Dobson, Manchester.
10469 Sewing Machines, C. Mundy, Glasgow.
10470 Ring Spinning and Twisting Frames, A. Whitaker, London.
10474 Propellers, R. Harvey, High Holborn.
10476 Cutting and Shearing Metals, R. C. Anderson, Liverpool.
10490 Gas Economisers, A. J. Jarman and W. C. S. Stebbing, London.

July 20th.

10493 Multiple Evaporating Apparatus, T. Slaiter, London.
10494 Motor Engines, H. P. Hall, Manchester.
10496 Heat and Fuel Economiser, J. Battye, Batley.
10505 Instantaneous Make and Break Electric Switches, E. Rousseau, Leyton.
10506 Centrifugal Pump, J. A. Radley, Lowestoft.
10507 Apparatus for Actuating Jacquard Machines, C. H. Priestley, S Deighton, and W. Deighton, Bradford.
10508 Liquid Meters, J. Mitchell, R. Laidlow, and R. Maclaren, jun., Glasgow.
10509 Steam Traps, J. T. Briddick, Northumberland.
10510 Combustion of Oils, A. McDougall, Manchester.
10511 Screws, J. M. Porter and J. A. Wright, Leeds.
10514 Securing Edge Tools to their Handles, T. H. Neal and W. B. Moyle, London.—[Complete Specification.]
10516 Cable Tramways, J. More, the younger, Glasgow.
10524 Electric Railways, B. J. B. Mills, Middlesex. (The Bentley-Knight Electric Railway Co., United States.)
10530 Safety Locks, J. Kaye, London.
10531 Locking and Unlocking Points and Signals, S. T. Dutton, London.
10534 Flexible Steam or other Fluid Joint, H. Skelton and B. Sutcliffe, London.
10535 Screw Propellers, R. W. Allen, London.
10542 Portable Forges, G. Cumming, London.—[Complete Specification.]

July 21st.

10568 Electric Bells, F. H. Royce, Manchester.
10569 Machine for Making Hinges, H. Stevens, Birmingham.
10570 Pulleys, A. Paget, Loughborough.
10572 Controlling Train Lighting Dynamos, J. H. Woodward, B. M. Drake, and J. M. Gorham, London.
10574 Boring Iron, J. Beaton, jun., Glasgow.
10581 Governors, J. J. Tyrrell and P. Deed, London.
10582 Signalling Apparatus, C. Wells, London.
10583 Car Couplings, F. Bruno von Alten, London.
10591 Tubular Steel Chains, F. Siemens, London.—[Complete Specification.]
10594 Propelling Ships, A. Damaskinos, France.
10601 Anti-corrosive Compositions, R Turnbull, London.
10603 Feed-water Heating Apparatus, L. Hussey. London.
10605 Smiths' Hearths and Portable Forges, F. T. Statham, London.

July 23rd.

10614 Self-acting Propeller Ventilators, J. Howarth, Manchester.—[Complete Specification.]
10621 Sleepers, E. Neal, London.
10626 Thermo-dynamic Heat Engines, A. Fehlen, London.
10637 Plates for Accumulators, G. Havenith, London.
10638 Low-pressure Steam Boilers, R. Dawson and G. R. Candelet, Manchester.
10641 Nut Shaping, V. Rhodes, London.
10645 Compressed Air Motors, P. Giffard, London.
10654 Electric Arc Lamps, W. R. Mortimer and J. Holloway, London.
10656 Stuffing Boxes, G. A. de Penning, London.
10657 Extracting Zinc from Pyrites containing Blende, J. Perino, London. [Complete Specification.]

July 24th.

10667 Explosive Engines or Motors, C. R. Binney and H. A. Stuart, Bletchley.
10675 Metal Belting, W. G. Cowlishaw, Longport.
10678 Gas Furnace, R. S. Casson and B. Talbot, jun., Wellington.
10684 Apparatus for Burning Petroleum, L. P. Guignard and J. Schweizer, London.
10691 Electrical Transmitting Instruments, A. J. Boult, London. (J. F. McLaughlin, United States.)—[Complete Specification.]
10699 Hot-water Radiators, W. P. Thompson, Liverpool. (A. Giles, United States, and E. S. Manny, Canada.)
10702 Railway Signalling Apparatus, J. Hunter, London.
10707 Converters Used in the Manufacture of Iron and Steel, J. Sheldon, London.
10711 Rotary Engines, O. Kohn, London.
10713 Ore Separators, A. P. Granger, London. - [Complete Specification.]
10714 Steam Boilers, H. C. Vogt, London.—[Complete Specification.]
10717 Rolling Mills, J. K. Bealey and S. Adams, London.
10722 Explosive Compounds, A. V. Newton, London. (A. Nobel, France.)
10723 Railway or Tram Cars, P. A. Newton, London. (E. Ambrose, New South Wales.)
10730 Electric Firing Gear for Guns, A. Noble, Newcastle-upon-Tyne.

July 25th.

10740 Engines for Controlling the Engines of Rolling Mills and the like, F. W. Stoker, Bradford.—[Complete Specification.]
10748 Gas Motor Engines, H. Campbell, Halifax.
10750 Boiler Furnaces, W. J. Graham and D. Graham, Manchester.
10760 Communicating Treble Power to Ship Propellers, G. Chapman, Glasgow.
10777 Steam Boilers, N. B. Clark and F. B. King, London.—[Complete Specification.]
10786 Rotary Pumps and Motors, P. Haddan, London. (W. B. Allyn, United States.)

July 26th.

10 9 Furnace Doors, J. Proctor, Manchester.
10800 Apparatus for Adjusting The Governors of Steam, Gas, or Air Engines, A. Earnshaw, Halifax.
10817 Reducing the Pressures of Steam or Liquids, G. Ralston, Newcastle-on-Tyne.
10826 Shells or Barrels of Locomotive and similar Boilers, M. Stock, London.

PUBLISHERS' ANNOUNCEMENTS.

BACK NUMBERS of "The Practical Engineer," from the commencement, can be obtained at either of our offices in London or Manchester, or by order of any Newsagent.

Vol. I. (bound), containing Nos. 1 to 44 inclusive, from March to December, 1887, price 6s. 6d., can still be obtained by order from any Newsagent, or will be forwarded, carriage paid, from either of our offices on receipt of the amount by postal order or stamps.

Numerous complaints having been made to us by Subscribers of the difficulty they experience in obtaining copies of the *Practical Engineer* in certain districts, we have to state that the Journal can be obtained by any Newsagent through the ordinary trade channels, and no difficulty should therefore exist in obtaining copies by order of any Newsagent.

For the information of the trade, we may state that copies can be obtained from either of our Offices in London or Manchester, or from any of the following wholesale houses.

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&c., &c., &c.

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EDITORIAL NOTICES.

All communications for the Editor of this Journal should be addressed to 6, Victoria Station Approach, Manchester.

Communications intended for insertion in the current week's issue should reach us not later than Tuesday Evening.

We cannot undertake to return rejected manuscripts or drawings unless accompanied by a stamped and directed envelope.

Contributors are requested to write on one side only of the paper. Sketches should be sent on separate sheets.

TO ADVERTISERS.

Advertisements intended for insertion in the current issue should reach us on Wednesday morning at the latest.

THE
PRACTICAL ENGINEER.
AUGUST 10TH, 1888.

ENGINEERING FORMULÆ.

To say that engineering rules are very useful to those who can do without them, may sound somewhat paradoxical, but, like most paradoxes, it admits of explanation. Perhaps the statement would be better understood if we were to put it another way, and say that engineering rules are very useful to those who know how they are derived. It frequently happens, however, that formulæ are applied with an utter disregard of the fact—which is true of most rules—that they are only capable of application between certain limits. To take a simple illustration, the laws of friction, as laid down in the ordinary text books of mechanics, are summed up in the three statements, that friction depends simply on pressure between the surfaces; is independent of the area in contact; and is independent of the velocity. As every engineer knows, however, the limits within which these statements are true are very narrow indeed, and that to design engineering structures by regard to these rules alone would lead to some very curious results. According to the law as stated, the thickness of a pair of skates or the length of a journal would be matters of indifference as far as the friction is concerned; yet, as every schoolboy or engineering apprentice knows, such is not the case.

Turning to another illustration, the strength of a boiler shell is nominally taken as proportional to its thickness, and no doubt, as far as internal pressure is concerned, this is correct. It would be a mistake, however, to imagine that this holds good for every size and pressure, and an amusing illustration of this recently came under our notice. A marine boiler about 12ft. in diameter being required for a very low pressure, the maker seriously proposed to construct the shell of plates about a quarter of an inch thick, on the ground that that thickness would be quite sufficient according to the Board of Trade rules, and afford a factor of safety of about six. We need hardly say that the Board of Trade rules were never designed to meet such a case, and had the boiler been constructed in conformity with them it would hardly have maintained its shape. The fact is that, within the ranges in which the Board of Trade rules are usually applied in practice, the question of stiffness does not need to be considered, and the case in point is an illustration of the way in which a rule may be ridden to death, and of the danger of using one blindly, or carrying it beyond the range its framers originally designed.

As another illustration of our meaning we may refer to the strength of furnace tubes to resist a collapse. As our readers will be aware, Sir William Fairbairn was the first to investigate this question, and his experiments, as far as they went, seemed to show that the strength of a furnace tube varies inversely as its length, and that with half the length, other things being equal, the strength is doubled. Further experiments, however, have shown that Sir William Fairbairn's deductions are only true as long as a certain relationship is preserved between the length and the diameter, and that the rule referred to is altogether wrong for very short tubes, such as those in vertical or marine boilers; while further, the rule pays little or no regard to the fact that a consideration of the crushing stress on the material imposes limits on the safe working pressure. It is not, however, our intention at present to discuss the general question of strength of flue tubes, interesting though it is, so much as to point out the way in which rules are frequently abused; and we simply mention the matter here because we have occasionally seen Fairbairn's rule applied with the most absurd results to structures which he never contemplated, and with regard to the strength of which his experiments afforded very little information.

The fact is that the conditions which engineering structures are designed to fulfil are so complex and variable that it is very often impossible to express them accurately in mathematical language, or at any rate in language sufficiently simple to render the formulæ of practical value, for it has to be borne in mind that a rule is of little use unless it can be readily applied. With a view to rendering a rule as simple as possible, therefore, complex functions are as far as practicable to be avoided. The formulæ gain thereby in simplicity, though it may be somewhat at the expense of accuracy and elasticity; and the rule very often, to carry our analogy a little further, does not stretch at the same rate as the conditions to which it is applied. This is the main point that has to be borne in mind, and which we most strongly impress on the minds of young engineers or those inexperienced in mathematical investigations. It is more important to learn the principles on which a formula depends than the formula itself, and a rule should not be slavishly followed because it happens to be correct in a particular case.

RAILWAY RACING.

In our issue of the 8th of June we made reference to the fact that the London and North-Western Railway had accelerated their train service between London and Edinburgh, reducing the time previously occupied for this journey of a little over 400 miles from ten hours to nine. We stated that the Great Northern and East Coast Railways had met this move on the part of the London and North-Western by an announcement of their intention of performing the journey in the following month in eight and a half hours, or at the rate, including stoppages, of 46½ miles per hour over the entire journey. This surprising feat the Great Northern have still further eclipsed by undertaking to perform the journey in eight hours. On the 1st inst. the service was commenced and accomplished in three minutes under the specified time, or at the rate of about fifty miles an hour, including the following stoppages: Grantham, five minutes; York, twenty minutes; Newcastle, five minutes; Berwick, five minutes; so that the journey of 400 miles was actually accomplished in seven hours and twenty-two minutes, giving an average speed while travelling of over 54 miles per hour. The London and North-Western, determined to abate no jot of their claim to a share of the traffic, have met this feat by a similar counterstroke, and on Monday last the 10-0 a.m. express from Euston, reached Edinburgh at 5-52 p.m., or in five minutes less time than its rival. The run from Euston to Crewe, a distance of 158 miles, was made without a stop, in two hours fifty-eight minutes. We wonder what our Transatlantic cousins will have to say to this. The longest run in America is the one from Fort Wayne to Chicago, a distance of 146 miles, or 12 miles less than from London to Crewe, but the time allowed to cover this is four hours ten minutes, or nearly one and a quarter hours more than is occupied on the English line with the longer journey. As a feat of swiftness, the run performed on Monday last is absolutely without parallel in the history of railways, and one which even George Stephenson in his most sanguine moments would hardly have permitted his fancy to indulge.

The question now arises, What will the Midland Company do? At present they seem to be out of the running altogether, and we can hardly imagine it possible for that company to shorten its time by one and a half hours, which will be necessary to place it in line with its rivals. As we pointed out, however, in our previous notice, it is heavily handicapped. Between London and Leicester it rises three times over four hundred feet, while between Settle and Carlisle it mounts upwards to over eleven hundred feet, and such natural obstacles to speed are not easily obliterated.

THE RAINFALL.

Popular estimates with regard to the character of the weather are not always to be relied upon, as imagination is largely drawn upon for facts. This remark, however, is hardly applicable to the persistent wet weather which has been experienced throughout England during the last month. From the report of the Meteorological Office, it appears that in July the total rainfall measured at Greenwich was 7·09in., which is more than the ordinary average, and 1·2in. in excess of the largest fall on record in July. Only on four occasions during the last 75 years has the fall for the month exceeded 5in., and on no occasion during this period has the total fall for June and July come up to that recorded this year, which amounted to 10·4in. There have been only thirteen years since 1813 when the rainfall for these two months has exceeded 6in., and in nine of these instances the wet July was followed by a wet August; so that, judging by analogy, it would appear very probable that we are destined to a still further infliction of wet weather.

MATERIALS OF ENGINEERING.—III.

Cast Iron.

The strength of cast iron is vastly different in tension and in compression. Thus, while the average tensile strength is only about 7 tons, its compressive strength ranges from 35 to 40 tons.

Mr. Hodgkinson's experiments gave a variation in tensile strength of from 5·6 to 10·4 tons per square inch, with an average of 6·8 tons, and a compressive strength of from 4·5 to 6·7 times the tensile strength.

Dr. Anderson found a variation of from 4·9 tons to 14·5 tons, with an average of 9·4 tons in tensile strength; but the ordinary commercial irons gave an average of only 6 tons.

Mr. D. K. Clark deduces for general calculations the average tensile strength at 7 tons, and the compressive strength at 49 tons per square inch.

Mr. Thomas Turner has obtained a maximum tensile strength of 15·7 tons, and a crushing strength of 92·5 tons. The Rosebank Foundry, Glasgow, has recorded 18·2 tons as the maximum in tension; but Major Wade, in America, has exceeded this, reaching the exceptionally high figures of 20·5 tons for tension.

It is not irons having a high crushing strength that are valuable to the founder, but those whose tensile strength is good. The most convenient measure of the strength of iron is that obtained by the transverse or cross-breaking test, which is partly tensile, partly compressive, and is therefore an intermediate test for *general strength.*

Test bars 1in. thick, 2in. deep, and laid upon supports 3ft. apart, should bear from 28 to 32 cwt. gradually applied before fracture, and deflect about ½in. The precise amount of deflection is not regarded as of much moment. A bar 1in. square, laid upon supports 4ft. apart, should sustain from 6½ to 7 cwt. before breaking. The bar which is regarded as standard is 1in. square and 1ft. long. On such a bar Mr. Turner obtained a maximum transverse load of 3,534lb., equivalent to 42·1 cwt. in the 2in. by 1in. by 36in. bar. The standard bar should, with average commercial iron, sustain about a ton before fracture. It is convenient to know that pounds weight on the standard bar, divided by 84, give hundredweights on the 36in. by 2in. by 1in. bar, and that hundredweights on the latter, multiplied by 84, give pounds on the standard bar. In Keeps' tests, the bars are ½in. square, and 12in. long, and are tested both for impact and for dead load. An impact test is also employed in France, the bar being 40mm. square, supported on knife edges 160mm. apart. A good bar will sustain a weight of 12 kilos. falling from a height of 80cm. before fracture.

For crushing tests, the height of the specimens should not exceed from one to three times their diameter, and they may be cubical or cylindrical in plan. Actually, shearing takes place at an angle of about 56° with the axis of the specimen.

The shearing strength of cast iron is variously given by Professor Rankine as 12·37 tons per square inch, and by Dr. Stoney at from 8 to 9 tons per square inch. It is, therefore, about equal to the tensile strength.

Strictly speaking, there is no limit of elasticity for cast iron, no yielding point; hence it is not employed much for tensile strains, but in structures subject to crushing chiefly, or for those requiring *rigidity,* for which purposes it is eminently adapted.

Too much reliance must not be placed on test bars, since in a substance so highly crystalline as cast iron various causes operate to affect its homogeneity. Thus the strength of the test bars is not uniform in proportion to sizes, even though cast from the same ladle; but the bars of smaller cross section are relatively much stronger than those of large area, the difference being partly due to the larger proportion borne by the chilled outer skin to the area of the section, partly to the grain being more open in the larger bars. Neither is the strength of bars of the same dimensions, cast from the same ladle, always uniform, but these will, when tested, show a difference of 10, 15, or 20 per cent, notwithstanding, also, that the crystalline appearance of the fractured ends will be precisely alike.

Test bars are cast from the same running of metal as the castings for which they furnish the test, and where a number of consecutive castings are being made, each day's series of bars is stamped similarly to the castings for the day. The bars are usually poured into dry sand, and frequently run vertically to ensure soundness. But though dry sand is more conducive to strong castings than green sand when bulk is considerable, the writer's experience has been that bars cast in green sand are a trifle stronger than those run in dry, and this is to be accounted for by the moisture in the former producing surface chilling, and does not in the least affect the fact that for large castings dry sand moulds are superior to green.

Though the usual practice is to cast test pieces from the same ladle of metal as the work itself, and to stamp them for inspection, evidently this opens the way for dishonest practices, unless the inspector can see the casts himself. The proper plan, therefore, is to cast the bars upon the work, and to knock them off afterwards. The conditions of casting, as well as the quality of the material, are then precisely alike in each. The behaviour of cast iron is so very uncertain, that in foundries doing a class of work where uniformity of results is essential, it is necessary, apart from tests made according to contract, to make frequent trial of the various brands and mixtures of iron employed, in order to maintain a high standard. For work of special character also, the only way to insure something like an approximation to quality required is to test the metal previous to use.

Factors of safety are used but slightly, or with wide latitude, in cast-iron work. The practice is to make castings rigid and massive in proportions far greater than are demanded by considerations of absolute strength. Pipes, cylinders, columns, are immensely stronger than theory requires. The same may be said of bases, frames, and work of that class. In structures subject to bending strains, as beams, girders, trusses, where cast iron was formerly employed, and in structures subject to impact, wrought iron and steel are now mostly used. But in cases where rigidity is a recommendation, and in which the metal can be so disposed as to allow an abundant margin of safety, in structures subject to compression, to a dead load in tension, or not liable to extreme variations in temperature, and for small parts whose stresses are almost *nil*, but which are subject to surface friction, cast iron is admirably suitable; and there is no structure so complicated that may not be made by casting, and the vast range in qualities of metal which can be obtained by judicious mixture renders cast iron simply invaluable to the engineer.

Test bars afford a valuable indication of the quality of an iron, but they only give a very general guarantee of the strength of a casting. The solidity and strength of castings depend on many things, which lie altogether within the province of the founder. Some defects are not even visible in the casting, unless and until it becomes broken. The signs of absence of feeding, or of insufficient feeding, or of bad skimming, for example, may not be visible, yet the heavier sections of metal may nevertheless be honeycombed with open spaces, and be far below the strength recorded by the test bars. Also the metal may be poured so dead as to become "cold shot," and yet the defect be invisible until fracture occurs. The mould may have been damp and badly vented, and blow holes exist, covered only by a thin film of iron; or the metal may be unduly massed in certain portions, and the casting be always dangerously near to breaking, in consequence of shrinkage strains.

For these reasons the inspection of castings is a task requiring something more than a comparison of test bars. A man must be quite practical to estimate the quality of a casting. Thus, no true moulder would be deceived by a fine skin, whether the casting were painted or unpainted. As a matter of fact, no castings ever ought to be painted until after inspection, but simply brushed over with boiled oil. Oil cannot conceal surface defects; paint may readily cover a multitude. When a casting is painted, bring a stiff penknife to work on the surfaces which the chipped-off risers show to have been cast uppermost, and if any "beaumontague" reveals itself, have all the paint scraped off again, and examine. Employers are not necessarily aware that any doctoring has been done on castings; the moulder himself often conceals defects before the castings leave his hands. Blow holes may be especially looked for on the top faces of castings, on projecting lugs and brackets—near cores, feeder heads, and runners. Shrinkage holes may be looked for in the vicinity of any large disproportionate masses of metal. If the point of a knife reveals nothing, try the pane of a hand hammer over doubtful areas, and judge by sound of the existence of hollow portions, covered by films of metal. Holes may be almost confidently looked for when a large chipped surface indicates the removal of a scab. If a casting has been scabbed, the chances are that the sand washed away has lodged in some other portion of the mould, occupying the place of metal. Castings which show signs of bad scabbing should therefore be minutely examined in their *upper* portions and underneath projections, should any exist.

Beware of disproportioned castings, whether smooth skinned or not. Ring them smartly with a hand hammer. If sonorous and free, they may pass muster, having probably been cooled judiciously, but if tense they will most likely fracture at some future time under ordinary, or less than ordinary, stress. This applies especially to gear wheels and pulleys having large bosses.

A smooth skin may be due to blackening alone, or to running with dull metal. Taken alone, it is not a test of a good casting, but in conjunction with other matters it affords evidence of care on the part of the moulder; yet a casting with a rough skin may nevertheless be a very good and sound one.

In loam work veins often occur in castings, which some people eye with suspicion. They are simply minute ridges on the surface, caused by the washing of the blacking into the cracks of the mould, and are not in the least detrimental. I have even known marks of joints which were originally in the pattern taken to mean repairs and patches put on a defective casting, and this by people who ought to have known better.

Some inspectors will condemn castings which should never have been condemned, and pass others having radical defects. A few blow holes in unimportant positions should never condemn a casting, nor should a rough exterior. All depends on use and purpose, and a truly practical inspector will take a broader grasp of these matters than a mere man of theory. J. H.

(To be continued.)

LEAD-TEMPERING OF ARMOUR PLATES.*

The writer refers to the results of firing Holtzer chrome-steel shells against armour plates, as appearing to place the victory in the Gun *v.* Armour controversy on the side of the gun. Various attempts have been made to secure a victory for the plates by increasing their resistance to penetration, by adding to the thickness; but the same purpose appears to have been effected by an alteration in the detail of the manufacture of the plate, according to which the material is tempered in a bath of fluid metal, notably of lead. The effect of this treatment is to increase the resistance of plates without introducing cracks or flaws throughout the mass; also soft steel in the cast state after metal-tempering assumes a molecular state like forged metal, and that armour plates, simply cooled in this manner, give a resistance equal to rolled plates. With very hard steels, also, samples after metal-tempering have been found free from cracks. The tempering process consists in immersing the heated pieces of steel in a bath of molten lead, and there leaving it to cool freely; but the particular temperatures to be employed in the bath will vary very widely with the nature of the material. Forged steel shells, of crucible steel, containing about 1 per cent of carbon, after this treatment, have a strength of 82·5 tons per square inch, and there is no fear of fracture from cracks produced in the tempering. Tests made from three bars of cast steel for shells showed, after lead-tempering, a strength of 54·2 tons to the square inch, and a final elongation of 9 per cent, as against 48·5 tons per square inch, with 6·5 per cent of elongation, after oil-tempering. The results of trials where Ogival-headed shot of chilled iron, or of chrome steel, were fired against steel armour plates, would appear to show that steel plates simply cast, and then tempered in lead, became comparable with rolled plates; and with compound plates the trials have shown that the penetration into the lead-tempered plate was less than in the case of plates treated in the ordinary manner, and that the number of blows before breaking up was very considerably greater.—W. H. G.

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* Foreign Abstracts, Proc. Inst. C.E

CONNECTING RODS.*

In this paper the author calls attention to a form of connecting rod which he had adopted in his practice with very good results.

It differs from the ordinary "marine" rod, first, in having jaws of sufficient length to hold both boxes; and, second, in having a cap which hooks over projections on the jaws. These projections are turned concentrically with the rod and the cap hooks are counter-bored to match. The cap is thus held in position by the combination of hooks, box-flanges, and bolts; but the long jaws and the counter-bore of the cap relieve the bolts of any other duty than merely clamping the parts together; and no particular accuracy need be observed, either in turning the bolts or drilling the holes for them. As compared with rods having the outer box secured by a transverse bolt, passing through eyes in the jaws, several advantages are claimed. The flat parallel sides of the head facilitate the operations of forging and finishing; the tensile stresses are taken by bolts, in which the required strength can be easily and certainly secured, instead of by eyes, of uncertain condition, cut out of the large forging; an unsightly swelling at the end of the rod is avoided and the weight sensibly reduced.

FIG. 1

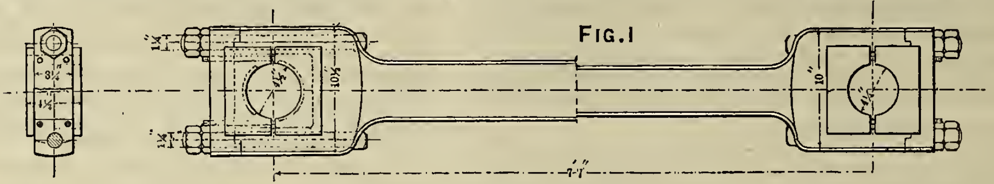


FIG. 2

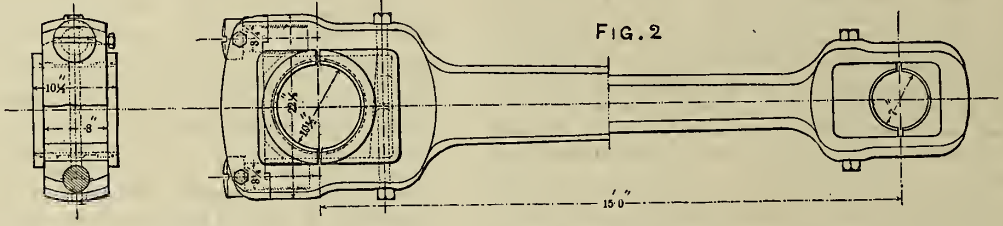


FIG. 3

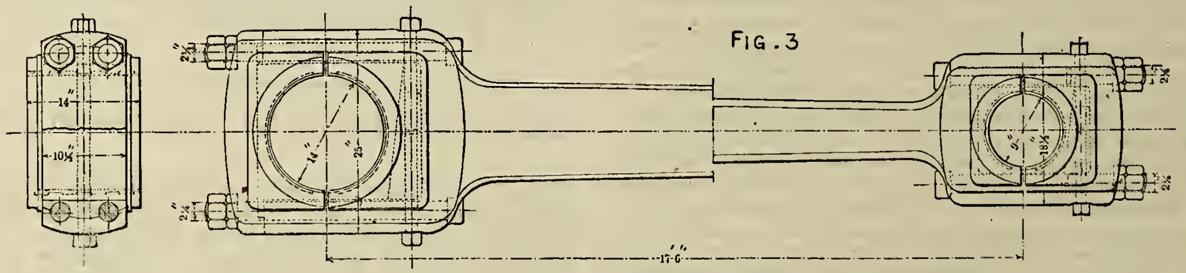
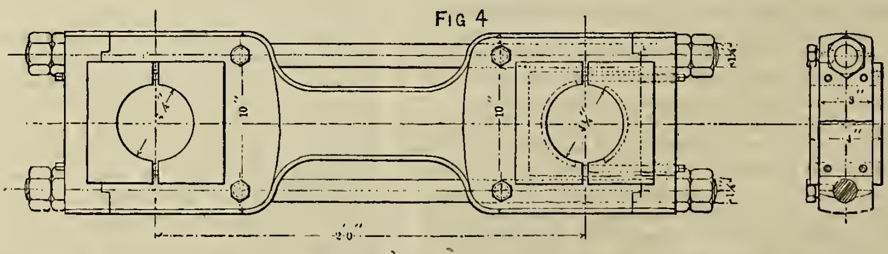


FIG 4



Rods, with the transverse bolt, are frequently seen with flat-sided heads, but the result is achieved by a disregard of nicety in proportioning, which is allowable only in small sizes. For the main rods of locomotives, having two pairs of drivers, the transverse bolt is most convenient; but this is a special case, and the precedent should not be blindly followed. As compared with the old strap rod we find the new form cheaper to fit up, and better in use. As compared with the solid-head rod the open end is a great convenience, except on crosshead ends, where the pins are removable. The jaws hold the boxes with equal rigidity, permit the use of full flanges on both boxes, and do away with loose collars on the crank pins. Fig. 1 shows a plain form of the new rod. This was designed for use in pairs, connecting the ends of a crosshead with a pair of fly-wheels. In such a case it is usually safer to take up the wear by liners, rather than by wedges or cotters. The opposing screws pass loosely through the caps, and are threaded in the boxes. We have discovered no advantage in the use of these screws for low speeds, and have had no opportunity to test them otherwise. For small rods we prefer the plain, straight caps shown in this figure. They are convenient for fitting, and the distribution of metal is better than appears at first sight. The bolts have round heads slightly countersunk, and are kept from turning by a spline. Fig. 2 is the rod used in a pair of horizontal, coupled, blowing engines, with 52in. by 60in. steam cylinders.

Here a wedge was almost a necessity, and to clear the adjusting-screws, tap bolts, instead of through bolts, were adopted to secure the caps. As before, the holes are loosely drilled through the caps; the holes in the rod being threaded by special taps. The bolts are steel, 3½in. in diameter, and are chased five threads to the inch. All parts, excepting the boxes, are hammered steel. The wedges are full width, and threaded for the adjusting-bolts, which are in tension. The boxes are "Eureka" steel, cast, fully faced with babbitt. Fig. 3 is a rod designed for a double crank, where a longer journal and consequent wider head, admitted four through-bolts, spaced to clear the wedge-adjusting screws. The crosshead end has the wedge under the cap, an arrangement that tends to preserve the correct length between centres of journals. Practically the same end may be secured in a rod like fig. 2, by the occasional introduction of a liner between the cap and the box. In fig. 4 we have one of a pair of short links, connecting the journals of a beam with a crosshead below. The construction is similar to fig. 1, except that the bolts pass through both ends, and are kept from slipping when the caps have to be loosened by the small set-screws shown on the sides of the heads.

In the construction of these rods, the head is first forged solid. Holes are then drilled for the interior angles, and a block slotted out, forming the jaws. As this operation, particularly in large sizes, is likely to cause a slight springing, it should be completed before the projections on the jaws are turned to a finish. The boxes may then be fitted, and the outer ones utilised as a centre for finishing the projections.

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* Paper read before the American Society of Mechanical Engineers, by Mr. W. F. Mattes.

AN ENGINEER'S LIFE AT SEA.—XI.

BY A SEA-GOING ENGINEER.

Circulating and Service Water.

Besides the circuit of the steam through the engines, the course of the circulating water must be understood. This we may call the water circle, in contradistinction to the steam circle previously considered. Steam, on its course through the engines changes its form to water before returning to the boiler, there to be again transformed into steam. With the water circle, however, the process is more simple. It both enters as water and leaves as water, but instead of losing heat on its course, like the steam, it has gained some of that lost by the other. These two circles are in rolling contact, touching at the one point where heat passes through the condenser surfaces, and revolving in opposite directions, as such circles must, one losing heat and thus passing from hot to cold in its revolution, the other gaining heat and passing from cold to hot. This analogy is not mere fancy, but gives us a glimpse into the inner heart of the engines, for such transference of heat is the secret of all their power.

In the circulating pump, sometimes large rubber valves are used, sometimes a number of small ones. The valve and guard, when in position, have usually a split pin through the end of the brass or gun-metal stud to keep it secure. If iron split pins instead of copper ones are put in, there will be trouble, for after a week or two of work the pins will be found to have mysteriously vanished, leaving no trace, to the astonishment of the inexperienced. It is, however, caused by the chemical or galvanic action of sea-water on iron, especially when in contact with brass, oxidising it into a spongy black substance which can be cut with a knife. Beyond breakage of pump gear, failure of valves, or leakage into the condenser, the circulation of the water will not give much trouble except in rare cases, such as when once the gland on a sea discharge valve sprang off its stripped studs, and called attention to itself by the fountains of water which sprang from it at each stroke of the pump and dashed about the surrounding storeroom. The gland had then to be shored down after repacking, till the studs could be removed.

All rubber valves require attention in port. On removing them, if they will not bear twisting and doubling by the hand without splitting, they should be rejected. They will always be found beaten out to a larger diameter than their original one, and perhaps in consequence riding on the studs which secure the valve seat to the cast-iron pump ; a strip of rubber has then to be cut off all round. Frequently the hole in the middle has got too large. Then, if the valve is otherwise good, a grummet is put in to fill this and keep it in a central position. It is usually best to turn the valve upside down when overhauling, not only to take the set out of it, got from the curved guard, but also because, the grating having marked the lower face of the valve with ridges, it is better to have a smooth surface in contact with the valve. With the head valve removed and bucket drawn out, the foot valve has then to be got at. Though a box spanner may loosen the nut, yet our "third" will probably have to make a headforemost descent into the pump, for the overhauling of it is his special work. This, which appears a formidable attempt to the inexperienced, is usually easier than it looks. A block of wood should be laid by the studs to prevent them hurting the doubled-up operator, and in every case one man, at least, should be at hand to assist; it is unsafe to omit this. It should be made an invariable rule that a man be never sent where the sender is unwilling himself to go. Especially should this be adhered to if there is even an appearance of risk in the operation to be carried out. Though this is sometimes evaded by unworthy "chiefs," "seconds," or "thirds," yet such readiness to undertake the hardest and most disagreeable work when necessary will gain respect from the men in a way that nothing else will do.

Besides the circuit of water to and from the sea through the circulating pump, a somewhat similar circuit through the water service pipes has also to be considered. This flows by gravitation from the surrounding sea, for both engines and engineer are beneath its surface. After being used for cooling purposes, it runs into the bilges, washing them out, but at the same time stirring up all ashes, grease, and foreign substances there, to give trouble in the bilge pumps while on its return to the sea.

For cooling the stern gland is usually slackened back so as to allow a little water to leak by it all the time. The engineer is thus sure that it is not too tight, and the trickle of water prevents overheating, which would be most dangerous at this place. Once a watch at least a visit should be paid to this gland, preferably at the relief of watch. Thus an engineer is always in the engine-room in case of emergency. The "thrust" rings are also kept continually cool by jets of cold water. The cranks and bearings, however, should, as far as possible, be run without water. If this be found impossible, owing to bearing surfaces being too small, the water must at least be kept off the rubbing surfaces. If this be not done, not only is the lubricant washed away, but it forms with the water a frothy paste which chokes up oil holes, and may lead to worse heating than before. Should a crank pin get hot—and it may happen to the best engineer—the water must never be turned on to the brass itself, as this, by contracting it, will increase the evil, tearing the surfaces into grooves, and perhaps bringing the engine to a stand with the friction. Every designer of engines strives to compress them into the smallest space, and so gain more cargo room. This frequently leads to a dangerous reduction of working surfaces, and increase of both relative and absolute load on them. The moment that heating is observed by the smell of the burning oil, or by feeling by hand, the engines must be slowed down, and water run upon the cheeks of the crank, so as to contract the diameter of the latter. Sulphur put in with the oil is sometimes used for cooling quickly, but after using it, and before opening up the engines again, the oil pipes should be washed out with water to clear them as well as the bearing surfaces. Thus every foreign substance will be removed before a final supply of oil is poured down, and the engines get under way again. When new engines show persistent heating, with sufficient bearing surfaces, it may be due to faulty alignment of shaft, or to badly bedded brasses. In such cases silver sand is sometimes put in to grind the surfaces true to each other, and then washed out, and the brasses run with oil alone.

Some brasses are fitted with white metal which melts out before much injury can be done to the brass. Frequently this metal is found to be loose in the brass owing to shrinkage after pouring in. In one instance, an engine had run well for some months without any trace of heating. Its low pressure crank brass was then overhauled, and it was found that nearly all the white metal had disappeared, leaving only fragments about the size of small shot. This was somewhat of a mystery, for this brass had always run cool and never given trouble ; but apparently the low-pressure engine had been throwing the work on its high-pressure companion, and the surface of brass left was large enough for its work.

Frequently a brass will crack right through into two pieces along a fore and aft line of pin or shaft, usually by overheating, at which time the thinnest part of the metal gives way. This, however, will not impair the efficiency of the brass as long as care is taken that no ragged edges are left to break off while at work, and thus score and overheat the bearing.

When a guide gets hot the water must on no account be played upon it, or it will most probably crack in horizontal lines. If however, such should occur, these cracks should be cut into oil ways. As they will be only surface cracks, this will remove them, and the guide will be the better for the increased lubrication. Heating of top-end brasses is readily overlooked, owing to the heat from the steam keeping them always hot, but practice enables any increase of heat to be readily detected. In feeling them, the hand must be got inside the fork of the rod and on to the brass itself. This for a novice is always an ordeal, as he prefers to keep at a respectable distance from the rushing swinging mass of the connecting rod. It should not be attempted for the first time until after seeing it done by one more experienced, after which it will soon become easy.

In all cases of heating, the water service is an indispensable ally. In bad cases the hose has to be got out, but where possible the cooling should be done with the ordinary pipes. With guides or top end brasses, however, it may be necessary to insert a small plug of wood in the mouth of the pipe, to contract its area, and so enable the jet to issue with sufficient force to reach the place required.

Though constant and regular feeling of all working parts cannot safely be neglected, yet the ear will often detect any approach to heating, and it is probably this sense upon which an engineer must rely most while on watch. After coming on watch, the cranks must be specially looked after for the first half-hour. Some engineers pride themselves on running with little or no water on the pins, and in order to gain credit they have been known to reduce or shut off the water at the end of their watch, and thus run the next engineer into the danger of getting hot pins or bearings, which only the greatest vigilance can enable him to escape. It will usually be found a good plan also that the one coming on watch should oil round for himself at the beginning of a watch. He thus has the matter in his own hands, and sees the condition of the engines when the previous supply of oil has exhausted itself, information which is of the utmost importance to him.

PUMP CONNECTIONS.—I.

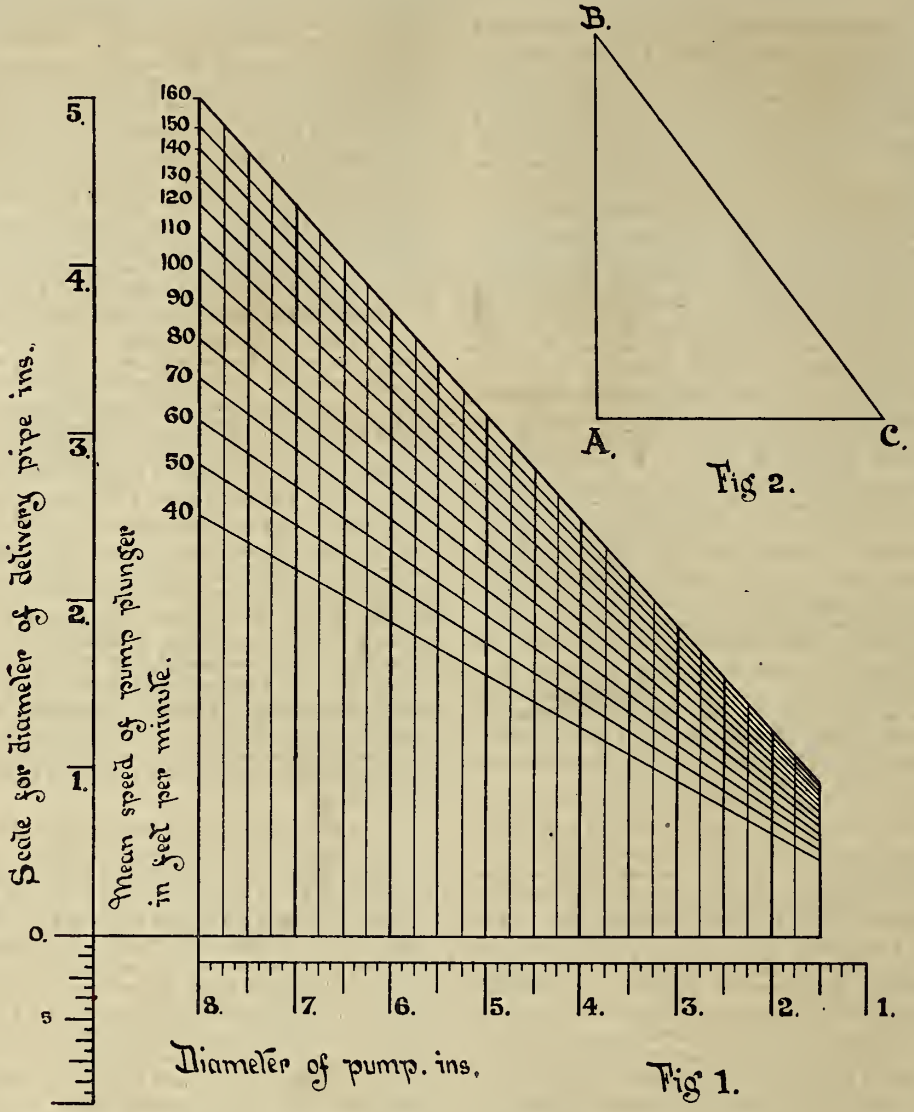

Fig 1.

Fig 2.

The Feed Pump.

In so many cases is the good working of a pump marred by faults in the arrangement or proportion of its connections, that we think a few words on the subject might be of some use to many of our readers.

Now, it will be understood that this article does not deal with the pump itself, but with its connections only.

It has been found in practice that the best speed for the water to pass through the delivery pipes from feed pumps is 400ft. per minute, and in no case should it exceed 500ft. per minute, so that for the former speed, d, the diameter of the delivery pipe,

$$= \sqrt{\frac{D^2 \times S}{400}}$$

in which D = the diameter of the pump ; S = the speed of its plunger in feet per minute, or stroke in feet × number of strokes per minute. Or this formula may be written—

$$d = \frac{D}{20}\sqrt{S}$$

which is perhaps a more convenient way ; but the diameter may be more readily found by reference to the accompanying diagram (fig. 1), which gives the correct diameter of the delivery pipe of pumps from 2in. to 8in. in diameter, at speeds of from 40ft. to 160ft. per minute, which are the limits usually found in practice. If, as is sometimes the case, there are two pumps which deliver to the boiler through the same pipe, and are arranged to deliver at the same time, the pipe beyond the junction of the two from the pumps should have a sectional area equal to the sum of the areas of the branch pipes ; that is, if

d_1 = the diameter of one branch pipe,
d_2 = the diameter of the other branch pipe ;

then D, the diameter of the main feed pipe,

$$= \sqrt{d_1^2 + d_2^2}$$

or the diameter of the main pipe may be found graphically (see diagram, fig. 2, above) ; for we know from *Euclid's Elements*, Book I., Prop. xlvii., that in any right-angled triangle, the square, which is described upon the side subtending the right angle, is equal to the squares described upon the sides which contain the right angle ; so that if we draw the right-angled triangle ABC, making AB = the diameter of the branch pipe, and AC = the diameter of the other, then the length of the hypothenuse BC = the diameter of the main pipe of a sectional area equal to that of the two branch pipes combined. But looking at this point theoretically, the area of the main pipe might be less, as the resistance of pipes is mainly due to friction at the surface, and will consequently vary as the diameter, while the area varies as the square of the diameter, the resistance in the single pipe will be much less than the combined resistance in the two, so that its sectional area may be about 0·85 of the sum of the areas of the two branches.

If, on the other hand, the pumps are arranged to deliver alternately, the pipes will be of the same size throughout.

Now as to arrangement. The pipes should lead as straight as possible, and when bends are necessary the radius should not be less than three to four times the diameter of the pipe, and the delivery passages should always be above the top of the barrel,

REID'S PATENT TUBE STOPPER.

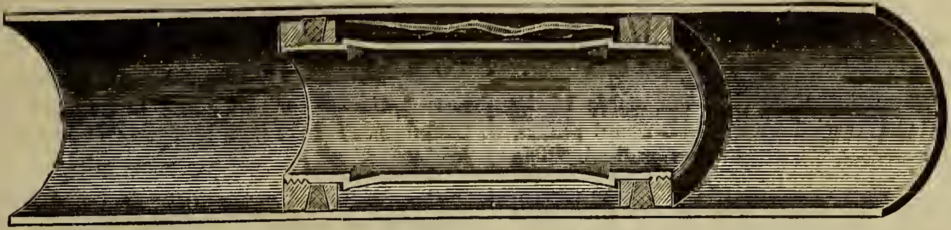

Fig. 1.

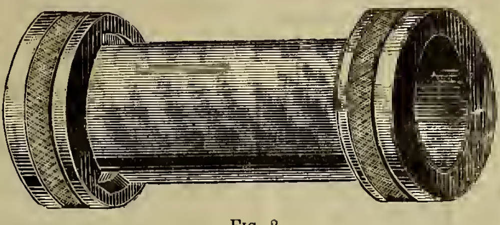

Fig. 2.

and in vertical pumps the delivery branch should be at the highest part of the barrel, so that there may be no place in which air can accumulate, as *air lodges* impair the efficiency of the pump; also by this arrangement change of the direction of the flow of water is avoided, which is a most desirable feature, for after a current of water has received an impulse, the motion imparted should be continued with a uniform velocity throughout its whole course; any change in its direction or velocity will cause considerable loss in power by overcoming its inertia.

An air vessel should be fitted on all delivery pipes near the pump, to ensure an even flow, and its capacity should be from one and a half to twice the capacity of the pump.

The suction pipe should be a trifle larger than the delivery, the reason being that the resistance has to be overcome by the pressure of the atmosphere alone; also the height of the suction pipe must not exceed 25ft. to 26ft., which is the greatest height to which water will rise to a pump. This was first demonstrated by Torricelli, as follows: He took a small tube about 3ft. long, closed at one end, and completely filled it with mercury, and then, stopping the open end with his finger, he inverted the tube with its open end in a vessel containing mercury, when, on removing his finger, the mercury in the tube descended until its top was at a height—measured from the level of the mercury in the vessel—of about 30in., where it remained stationary. Now, the density of mercury is 13·6 times the density of water, so that if this experiment had been performed with water, the height of the column of water which the weight of the atmosphere would have sustained would have been 13·6 times the height of the column of mercury; that is, 13·6 × 30in. = 408in., which, divided by twelve, gives 34ft. as the maximum theoretical height that water will rise to a pump, but in practice a perfect vacuum is not obtained, and the water will not rise to more than from 25ft. to 26ft. If the water to be raised is hot, there must be very little suction, and, if possible, the water should be allowed to run into the pump.

Now as to the arrangement of the suction pipe. In the first place, it should be at the lowest point in the pump, and there should be no part of the suction pipe higher than the suction branch on the pump; also great care should be exercised in making the joints in the suction pipe so that they may be perfectly tight, that the pump may not draw air, and if the pipe be long, a foot valve should be fitted just above the strum in the well. In some cases it will be found necessary to fit a vacuum vessel on it, which should be as near the pump as possible, to ensure its being properly filled at each stroke, the capacity of which should be from 1·5 to twice the capacity of the pump.

A New Method of Preparing Silicon.—A new method of preparing silicon has recently been proposed by Mr. H. W. Warren, in a recent number of the *Chemical News*. Small bars of "silicon eisen" are suspended in dilute sulphuric acid from the positive pole of a battery of two ferric-chloride cells, and are in contact with a platinum plate forming the negative pole. The iron dissolves, leaving a residue of graphite, silica, and amorphous silicon, which is heated to redness in a stream of carbonic acid gas, and then to a full red heat in a closed iron tube with some zinc. The zinc button thus obtained is dissolved in hydrochloric acid, when crystalline silicon remains behind.

REID'S PATENT TUBE STOPPER.

The accompanying illustrations represent a form of tube stopper recently brought out by Messrs. Reid and Co., of Bolton, which possesses one or two novel features. The tube stopper is shown in fig. 2, while fig. 1 is a longitudinal section of a defective smoke tube, with the stopper in position. As will be seen from fig. 2, the stopper consists of a tube somewhat smaller in diameter than the smoke tube to which it is applied. At each end of this is a flange securely fixed in position. Immediately behind each of these flanges is a ring of asbestos packing, which is backed by another washer which slides loosely on the stopper. The stopper is applied by means of a repositor, by which it is slowly forced along the leaking tube. When the position of the stopper is such that the full length of the fracture in the tube is included between the movable washers, the pressure of the escaping steam then, and then only, drives the loose washers asunder, like a pair of annular pistons. The asbestos rings are thereby compressed in thickness, and correspondingly increased in diameter, so that the stopper is automatically fixed in position, and the greater the leakage the more effectually does the stopper act. As the stopper is tubular, it will be seen that the heating surface of the injured tube is to a large extent retained. The invention is very simple and ingenious, and the facility and rapidity of its introduction, as well as its automatic action, will, we have no doubt, lead to its extensive adoption.

GAS EXPLOSIONS IN THE NAVY.

With the object of reducing the danger of explosions of gas in the bunkers of Her Majesty's ships, the Admiralty have issued new rules for the government of the Steam Reserves. According to these, directly after the coaling of a ship is finished, the engineer officer is to see that the coal shoots are quite clear of coal. Coal should not be taken on board wet, as moisture sometimes causes a rapid and dangerous generation of heat and gas. While the decks are being washed after coaling, the close bunker covers are to be replaced to prevent water passing into the bunkers, and the coal should always be kept as dry as possible. The ventilating pipes to bunkers, when so fitted, should be kept clear. No light, except in a safety lamp, is to be used inside the coal bunkers until it has been ascertained that they do not contain explosive gas; and special precautions in this respect are to be taken for a few days after coaling. Where coal bunkers are not provided with permanent ventilating fittings, the lids are to be taken off twice a week, and kept off at least ten hours during the week. Every precaution is to be taken to ventilate such bunkers before men are sent to work in them. In order to render the ventilation efficient, there must be at least two openings—one for the admission of pure air, and the other for the escape of foul air—and, where the two permanent ventilating fittings do not include both, the bunker lids are to be taken off periodically.

STANDARD SPECIFICATION FOR A LANCASHIRE BOILER.

(*Continued from page 356.*)

FITTINGS.

THE boiler to be supplied with the following fittings and mountings :—

One Steam Stop Valve, 6in. diameter.—The valve to be fitted with an external nut, carried by a crossbar and pillars, the crossbar and pillars to be of wrought iron or steel. The valve, seating, spindle, and nut to be of gun metal.

The junction valve to be fitted with an internal anti-priming pipe of cast iron. The pipe to have a length of 7ft. 6in., a bore of 6in., and to be perforated throughout its length along the top. The united area of these perforations, however, not to exceed the area of the junction valve by more than 25 per cent.[7] The pipe to be carried close to the crown of the shell by means of a suspender attached to a small riveted bracket at each end.

One Feed Check Valve, 2½in. diameter.—The valve to be fitted with an internal or external nut, at the discretion of the boiler-maker.[8] If the nut be external, the crossbar and pillar bolts carrying same to be of wrought iron or steel. The valve, seating, spindle, nut, and gland to be of gun metal. The valve to be fixed on the front end plate in the position shown in sketch ; to be fitted with a horizontal pipe internally for dispensing the feed. The pipe to have a length of 15ft. and with a bore of 2½in. ; and to be constructed in three lengths for convenience in handling. The last length of the pipe only to be perforated for dispersing the feed, and the end to be fitted with a blank flange. The pipe to be carried by three suspenders hung from small angle brackets riveted[9] to the shell.

A copper bend of U shape to be attached to the feed check valve for connecting it to the main overhead feed pipe, the bend to have a bore of 2½in., a thickness of ⅛in. in the body, and ⅝in. in the flanges.

One Blow-off Tap, 2½in. bore.—The tap to be either of "compound gland" or "inverted cone" construction, and made entirely of gun metal. The tap to be connected to the fitting branch on the boiler by means of a cast-steel elbow pipe, having a diameter of 2½in. where attached to the tap, enlarging up to 5in. or 6in. at its junction with the fitting branch. The length of this pipe to be such as to make the centre of the blow-off tap fall about 12in. in front of the boiler. This pipe to have a thickness of not less than ⅝in.

The blow-off tap to be fitted with a copper bend for connecting it to the waste pipe. The bend to have a length of about 12in., a thickness of ⅛in. in the body, and ⅝in. in the flanges.

One Scum Tap, 2in. bore.[10]—The tap to be of compound gland construction, and made entirely of gun metal. To be fixed on the front end plate in the position shown on sketch. A vertical cast-iron waste pipe to be attached to the bottom of the tap for connecting it to the waste pipe in the hearth pit, and a neatly-moulded brass collar to be provided for covering the opening where the pipe passes through the floor plates. The vertical cast-iron pipe to be connected to the main waste pipe in the hearth pit by means of a copper bend. The bend to have a length of 12in., a thickness of ⅛in. in the body, and ⅝in. in the flanges.

The scum tap to be fitted with a range of scum troughs inside the boiler. These troughs to be made in three 5ft. lengths, and to be connected to the scum tap by a cast-iron pipe, having a length of 5ft., and a bore of 2in. The bottom of each trough to have three openings, each opening to measure 1in. in length and ½in. in width, so that the united area of the openings will equal 4½ square inches. The joint surfaces between the troughs to be faced and made quite water-tight. The range of troughs to be carried by four suspenders hung from small angle brackets riveted to the shell.

The top of the troughs should be set so as to be perfectly horizontal, and half an inch below the water-level pointer on the front end plate.[11]

One External Dead-weight Safety Valve.—The valve to have a diameter of 3in., and to be loaded to three or four pounds per square inch in excess of the stipulated working load.[12]

One compound safety valve, arranged to blow off for high steam or low water. The valve to be either of the Hopkinson or the Kay type. If of the Hopkinson type, the outer valve to have a diameter of 4in., and the inner valve of about 2in.

Two glass water gauges to be fixed in the position shown in sketch. The gauges to be secured to the end plate with flanges and studs. The gauge glasses to measure ¾in. in diameter externally, and to be fitted with short brass waste pipes for deflecting the water from the front end plate when the gauges are tested.

One brass water-level pointer, to be fixed at a height of about 10in. above the level of the furnace crown, and half an inch above the top of the scum troughs, so as to indicate the level at which the scum tap is to be used.

One dial pressure gauge, 10in. in diameter, by Messrs. Schaffer and Budenberg. The gauge to be fitted with a straight pendant syphon, and to have a range of 150lb., the gauge to be fitted with suitable nipples for connecting to a M'Naught or Richards indicator.

One wrought-iron or steel mouthpiece for each furnace, finished off with a neat brass moulding outside, and fitted internally with a cast-iron arch piece surrounding the fire door for carrying the fireclay lining protecting the furnace front. The cast-iron door to be fitted with a sliding ventilating grid affording an area of about 50 square inches, as well as with an internal baffle plate.

Two dead plates and a complete set of fire bars in two lengths of 3ft. each, so as to make the fire grate 6ft. long.[13] The dead plate, as well as the bearer for the fire grate, to be carried by wrought-iron brackets, riveted[14] to the side of the furnace.

A cast-iron chair to be fitted in each furnace for carrying the fire bridge, the chair to be bolted to wrought-iron brackets, riveted to the sides of the furnace, and to be fitted underneath with a hinged door, for convenience in cleaning.

Two flue doors and frames to be fixed in the hearth pit in the front cross wall, in the position shown in sketch of setting. The doors to be sufficiently large to afford convenient access to a man.

Two dampers, with frames and the necessary chains, weights, and pulleys. The height of the frame to equal that of the side flue, and to afford a clear opening 12in. wide.

A complete set of flooring plates, with frames and fender flange. These plates to extend across the entire front of the boiler, as shown in sketch of setting plan. The plates to be of convenient width for handling, and those on each side of the central one to be rabbeted, each floor plate to be planed on the edges, and to rest on a chipping piece at each corner.

A complete set of spanners to fit all the nuts on the boiler

A cast-iron plate for covering the downtake at the back end of the boiler. The plate to measure about 9ft. 6in. in length by 2ft. 6in. in width and ¾in. in thickness, and to be suitably stiffened with ribs on the upper side.

Hydraulic Test.

When complete, the boiler to be tested by hydraulic pressure to 180lb. on the square inch. The steam stop valve, as well as the feed valve, the scum tap, and the blow-off tap, with its connecting elbow pipe, to be tested along with the boiler.

Delivery of Boiler.

The maker to deliver the boiler on to the premises of the purchaser, and place it on its seat, finding a skilled man to superintend the work, as well as all lifting and hauling tackle. The purchaser to find the requisite timber and all unskilled labour. The maker to fix all the boiler mountings and fixings in position, finding all the necessary bolts, cement, &c., so that the boiler may be left quite complete and ready for work.[15]

Note 7.—The object of the anti-priming pipe is to ensure the supply of steam being drawn over as large a portion of the boiler as possible. If the area of the perforations is excessive this object is defeated, and the anti-priming pipe becomes worthless. This is a point boiler-makers sometimes overlook, and several cases of priming that have come under notice have been remedied by simply plugging a number of the holes in the pipe so as to distribute the supply over a greater length.

Note 8.—Some makers prefer the valve fitted with an internal nut, while others prefer the nut outside. The point is not one of very great importance, though considering the present high pressures and the greater convenience of access, the external nut and crossbar is perhaps on the whole to be preferred.

Note 9.—These brackets are sometimes bolted to the shell instead of being riveted, but this practice is very objectionable. It is liable to lead to leakage, and thus cause corrosion.

Note 10.—A scum tap is not necessary unless the water be dirty or heavily charged with lime salts; it is, however, frequently applied when there is no necessity for it.

Note 11.—The level of the troughs should be carefully adjusted after the boiler is placed on its seat; this is a point that is sometimes overlooked. The troughs are sometimes set level when the boiler is at the works, without any regard being paid to the fact that when on its seat the boiler is, or should be, placed so as to have a fall of about 2in. towards the front for the purpose of drainage, and unless this is subsequently rectified, the efficiency of the apparatus is seriously impaired.

Note 12.—The extra load is placed on the dead-weight valve in order that the low-water safety valve, which is fitted with a waste pipe, may be the first one to give warning, and thus prevent the boiler-house from being filled with steam, which would be the case if the two safety valves began to blow at the same moment.

Note 13.—Should circumstances render it necessary, the length of the firegrate might be increased to 7ft.

Note 14.—The brackets are sometimes bolted, but this is exceedingly objectionable on account of the risk of leakage.

Note 15.—The question of delivery of boiler will of course depend to some extent on the circumstances of each case. It has been thought well, however, to insert a clause in order that the reader may know what is the usual practice.

COPPER STEAM PIPES FOR HIGH PRESSURES.—II.

(Continued from page 364.)

While these points were under consideration, I had brought to my notice by Mr. W. Elmore a method of making copper pipes of any required diameter, length, or thickness by electro-deposition, and I was instructed by the Committee of Lloyd's Register to proceed to Mr. Elmore's works and witness the operation of making these pipes, with a view to reporting thereon for the information of the committee. The process is briefly as follows: A mandril is surrounded by ordinary unrefined Chili bars arranged upon strong supporting frames in a depositing tank of sulphate of copper, and the copper is dissolved or decomposed, as will hereafter be explained, and is deposited in the form of pure copper on the revolving mandril, leaving the copper in the form of a shell or pipe, of any thickness required, fitting closely to the mandril. When the required thickness has been deposited, the pipe and mandril are exposed to the action of hot air or steam; then the copper, expanding more than the iron, admits of the mandril being drawn, leaving the copper in the form of a pipe, without a seam, perfectly round and true, both internally and externally; or the pipe may be expanded or made larger by rolling or other mechanical means, and then the mandril withdrawn.

The deposition of copper by electricity is not at all new. It has been in use for years for electrotyping purposes, and for separating copper from its impurities, and particularly for extracting gold and silver. But copper thus refined is wanting in cohesive properties, and without some means of increasing its density, which would give to it, at the same time, both tenacity and ductility, it would in such a form be useless for mechanical purposes, and the ingenious manner in which this difficulty is overcome by the present process constitutes its most important feature.

A burnisher or planisher, composed of a small square piece of agate, being the hardest and smoothest substance suitable and available, is supported upon proper arms and levers, and the agate is allowed to press lightly upon the surface of the copper on the revolving mandril. The burnisher is caused to traverse from end to end of the mandril by means of a leading screw at any required speed. After it has traversed the whole length of the mandril, it is automatically reversed, and commences its journey backwards. The speed of the revolving mandril, and the speed of the traversing burnisher, is so adjusted or arranged that the whole surface of the copper is acted upon by the burnisher, the result being that every thin film of copper deposited upon the mandril must be separately acted upon, burnished and compressed into a dense and cohesive sheet of pure copper possessing a great amount of tenacity and ductility, as will be seen from the results of the experiments and tests which I have made, and which will be referred to further on. The impurities or dross fall to the bottom of the tank in the form of mud, and when washed, dried, and smelted in a crucible, the gold, silver, &c., contained therein can be easily separated. In fact, during the operation of refining copper from the rough Chili bars, the finished article is automatically produced in the form of a pipe, and all the impurities are extracted and can be collected.

While I was present at the works of Mr. Elmore, the patentee of this process, four pipes were made. The mandrils had been revolving in the baths for about 170 hours, and the copper in this length of time had reached a thickness of ·198in. The pipes were taken off the mandrils in my presence, and the ends of the pipes cut off, so as to present a portion of the pipes acted upon by the burnisher. The remaining portion, or rough ends, shows the nodules, or rough copper, not acted upon by the burnisher, which is in a completely brittle condition.

It is well known that the structure of ordinary electro-deposited copper is purely crystalline, and easily disrupted under stress. The adjoining faces of the crystals, of which the whole mass is composed, appear under the microscope to be separated from each other, and have very slight cohesive power.

To describe more in detail how the decomposition of the unrefined copper is effected, and how the deposit takes place, I may state that the unrefined Chili bars are cast into slabs of the required length of the pipe, and these are arranged longitudinally in a wooden tank, in such a manner that the faces of the slabs are approximately at equal distances from, and parallel with, the surface of the cylindrical mandril, both at its sides and underneath it, leaving the upper side open for the burnisher to travel over. The mandril is fitted with a properly insulated spindle, running in insulated bearings, and driven by suitable wheel gearing, &c. The whole of this arrangement is immersed, as before stated, in a bath of sulphate of copper. The mandril forms what is termed the cathode, and the copper bars the anode, of the *electric circuit*. The cathode is connected with the negative pole of an ordinary dynamo machine, and the anode with the positive pole. When the dynamo is set in motion, an electric current passes through the solution, and the following chemical changes take place. The sulphate of copper is decomposed, and the sulphuric acid is transmitted to the anode, there to attack and dissolve or combine with a quantity of copper equal to that which has been liberated or deposited upon the cathode.

Two of the four pipes I witnessed being manufactured I brought to London. One of these pipes I had fitted with strong flanges properly secured in an apparatus especially made for the purpose, and tested to destruction. The other pipe I had cut into two pieces, and one of these pieces, marked A, is on the table for inspection. The other piece was cut and flattened out into a sheet, from which six test pieces were cut and prepared for making tensile tests. I also obtained from Messrs. J. Wilkes and Sons, of Birmingham, two solid drawn copper pipes of similar dimensions, and had them cut and tested in a like manner. The piece marked B is cut from one of these pipes.

In addition to these pipes, I obtained from Messrs. Clelland and Thornburn, the well-known coppersmiths, of Glasgow, a brazed pipe of the same dimensions, made especially for my experiments, which was also tested to destruction, together with a sheet of best rolled copper, so that corresponding test pieces could be made to those made from the electro-deposited pipe and the solid drawn pipe.

The results of these mechanical experiments are most interesting.

Pipe A, electro-deposited, stood a pressure of 3,450lb. per square inch before it burst. The material stretched and the pipe expanded uniformly until the copper was reduced in thickness from $\frac{3}{16}$ of an inch to $\frac{1}{16}$.

Pipe B, solid drawn, stood a pressure of 2,200lb. per square inch. It also expanded, but not with the same uniform character as pipe A.

Pipe C, brazed from sheet copper, also stood a pressure of 2,200lb. per square inch, and burst, as all brazed pipes do, near the line of brazing.

The tensile strength and ductility of the copper cut from pipe A is given in the following table :—

TABLE A.

DEPOSITED COPPER.

Marks on Specimen.	Dimensions in inches.			Tensile strain in tons.		Elongaton per cent.		Contraction of area per cent.	Remarks.
	Breadth.	Thickness.	Area.	Total.	Per sq. in.	In 8in.	In 5in.		
A 1	2·0	·175	·351	8·36	23·80	13·7	20·0	73	Electro - deposited copper cut circumferentially from the pipe.
A 2	2·0	·18	·36	8·36	23·22	13·0	17·5	68½	
A 5	1·0	·18	·18	4·32	24·00	12·9	16·0	82	Cut longitudinally with the pipe.
A 6	1·0	·18	·18	4·27	23·70	13·2	13·2	71	

The tensile strength and ductility of the copper cut from pipe B is given in the following table :—

TABLE B.

SOLID DRAWN COPPER.

Marks on Specimen.	Dimensions in inches.			Tensile strain in tons.		Elongation per cent.		Contraction of Area per cent.	Remarks.
	Breadth.	Thickness.	Area.	Total.	Per sq. in.	In 8in.	In 5in.		
B 1	2·0	·195	·39	8·0	20·5	3·75	7·1	12·8	Solid drawn copper cut circumferentially from the pipe.
B 2	2·0	·195	·39	8·0	20·5	3·75	6·9	12·8	
B 5	1·0	·190	·19	3·8	20·0	2·90	7·0	43·6	Cut longitudinally from the pipe.
B 6	1·0	·190	·19	3·8	20·0	3·10	7·0	36·8	

The tensile strength and ductility of copper cut from sheet copper, such as would be supplied for making pipe C, is given in the following Table :—

TABLE C.

ROLLED SHEET COPPER.

Marks on Specimen.	Dimensions in inches.			Tensile strain in tons.		Elongation per cent.		Contraction of area per cent.	Remarks.
	Breadth.	Thickness.	Area.	Total.	Per sq. in.	In 8in.	In 5in.		
C 1	2·0	·265	·53	7·46	14·0	45·0	30·0	44·5	Rolled sheet copper cut in the direction in which it was rolled.
C 2	2·0	·265	·53	7·46	14·0	44·0	30·0	45·5	
C 5	1·0	·265	·265	3·72	14·0	45·0	35·5	31·0	Cut across the direction in which it was rolled.
C 6	1·0	.265	·265	3·71	14·0	42·0	33·5	31·5	

It will be seen from these tables that the tenacity in the normal state of these three descriptions of copper—the electro-deposited, the solid drawn, and the rolled sheet—are 23¾, 20¼, and 14 tons per square inch respectively.

The very superior ductility of the pure electro-deposited copper is clearly shown by the manner of breaking, the elongation being chiefly confined to the neighbourhood of the fracture; and whereas the contraction of area at the fracture in the solid drawn copper is 12·8 per cent, and in the sheet copper 45 per cent, in the deposited copper it averages 72 per cent.

The tenacities shown by the test pieces are confirmed by the pressures at which the electro-deposited and solid drawn pipes burst under hydraulic pressure, and, as before stated, the uniformity of the deposited material is very conspicuous.

(To be continued.)

THE WORK OF THE PATENT OFFICE.

FROM the fifth report of the Comptroller-General of Patents, Designs, and Trade Marks for the year 1887, which has been published as a Parliamentary paper, it appears that the total number of applications for patents in 1887 was 18,051, for designs 26,043, and for trade marks 10,586. These numbers are considerably in advance of the average of the three previous years. From a table given, it appears that the proportion of applications made by persons resident in the United Kingdom was 76 per cent—a total which varies but slightly from the average. Of the applications made during the year, 53 per cent were proceeded with. There were 26 applications made under the provisions of the International Convention, which was joined during the year by the Government of the United States. With regard to trade marks, 4,916 marks were advertised and 4,740 were registered. The total receipts for the year amounted to £124,279, of which £105,599 was for patent fees, £4,855 for designs, and £8,463 for trade marks, while £5,360 was received from the sale of publications. The chief items of expenditure were £47,110 for salaries, £2,304 for pensions, £3,050 for stationery, and £22,300 for printing specifications, lithographing, drawings, and other such expenses. A balance of £42,702 was left at the end of the year.

CORRESPONDENCE.

We do not hold ourselves responsible for the opinions of our Correspondents.

THE BRANDING OF BOILER PLATES.

To the Editor of "The Practical Engineer."

SIR,—In your issue of July 6th, you made a few remarks upon the use of the word "best" as a brand for boiler plates. Most engineers know that "best" boiler plate is far from being of best quality, to attain which we must buy "best best," or even "best best best." Such a method of branding is both ridiculous and deceptive. It sometimes leads the public to believe that a plate manufacturer whose "best" plate fails badly is an unscrupulous fellow, and occasionally enables a shoddy boiler maker, who may knowingly use such plates, to throw dirt in the eyes of a jury.

American engineers are not usually ahead of us in anything, but in respect to boiler-plate branding they are most decidedly, for there they stamp a plate with its tenacity in pounds per square inch, and according to such brand they are used. If the elongation percentage were also stamped on every plate, there would be no excuse for a boiler-maker using poor material, and in case of accident occurring, the boiler-maker whose work showed careful handling in construction could fall back complacently on a brand—

26 TONS.
20 % in 8ins.

Manufacturers of boiler plate should agree upon some such national system of stamping, if they would avoid the inevitable stigma attaching to the failure of a plate marked "best," when they know that best means worst. It is not easy in many trades to know whether first quality, No. 1, best, highest, superfine, or very best be really A1; but there is no excuse in boiler plates, whose qualities can, for practical purposes, be established and known by such a brand as above given.
—Yours truly, ENGINEER.
July 30th, 1888.

COLLAPSING PRESSURE OF FURNACE TUBES.

To the Editor of "The Practical Engineer."

SIR,—I regret I cannot comply with the request of Mr. T. Hewitt, as there are several reasons why I prefer not to advise in special cases.

With reference to the inquiry of Mr. W. J. Craig, junr., Fairbairn's formula makes the collapsing pressure of a flue 27in. in diameter, 22ft. long, and ⅝in. thick, as over 190lb. per square inch, and the formula given by me in your issue of 6th July would make it 115lb. per square inch. I think there is a general opinion that the pressures given by Fairbairn's formula are much too great when the flues are short, and when they are not of small diameter.

Sir W. Fairbairn considered that the strength of a flue was inversely as its length; but there must be a limit to this. It can easily be seen that a very long flue is not proportionately weaker than a short one; a flue 50ft. long is not fifty times stronger than one half a mile long. He also assumed that a flue is weaker in proportion as its diameter is increased. This is quite correct *when the load is the same*; but the load is greater in proportion to the diameter, and therefore the strength decreases as the square of the diameter. The factor of safety is less important than an accurate determination of the limit at which disaster may be expected.—Yours truly, W. J. ELLIS.

PITCH OF PROPELLERS.

To the Editor of "The Practical Engineer."

Sir,—After reading "Omicron's" able reply to your correspondent "Port Glasgow," on the above subject, I think it must be a slip on his part to say that, "as the distance G is to the circumference of 8ft., so is the *difference* between the two distances D and E to the pitch of the propeller at 8ft. diameter." Should it not rather have been stated "as the *arc* of the circle (8ft. diameter) of which the distance G is the *chord* is to the circumference of 8ft., so is," &c., &c. I am aware that this would not make much difference in the pitch; still it would be a little more accurately found, at least to the mind of yours truly,

West Hartlepool. Orion.

P.S.—I find in a propeller 17ft. 3in. pitch, where G = 35in., that this variation is about 5in. in excess of the actual, or the pitch is found to be 17ft. 8in. by taking the *chord* instead of the *arc*.

PROPOSED ENGINE ATTENDANTS' ASSOCIATION.

To the Editor of "The Practical Engineer."

Sir,—Allow me a little space in your excellent journal to inform your Manchester readers of the formation of the Manchester Engineers' Mutual Improvement Society. The society was formed in January last, with the object of discussing subjects of interest to those engaged in mechanical pursuits. The next meeting takes place on September 8, when Mr. Morley will read a paper on "Latent Heat."—Yours truly,

Manchester, August 4. R. Holt, Sec.

QUERIES AND REPLIES.

Long Railway Tunnels.—Will any of your readers be good enough to give me the names of the three longest railway tunnels in England; also state where they are and what companies they belong to.—E. L. Darnall.

Answer.—The three longest railway tunnels in England are (1) Standedge tunnel, 5,340 yards; (2) Woodhead tunnel, 5,320 yards; and (3) the Box tunnel on the Great Western line, which is 3,080 yards long.—W. T.

Answer.—In answer to "E. L. Darnall," the three longest tunnels in England are—Severn, belonging to the Great Western Railway Company, which is 7,664 yards long; Standedge, belonging to the North-Western Railway Company, 5,342 yards long; Woodhead, belonging to Manchester, Sheffield, and Lincolnshire Railway Company, 5,297 yards long.—Edward J. Farley.

Hauling Drum.—I am fitting up a drum to haul stone from a quarry 150 yards deep, with an incline of 45 deg. I have a pinion 7in. in diameter, 1½in. pitch, on crank shaft of 10 H.P. engine, which gears in a spur wheel 2ft. in diameter. On the same shaft is another pinion 10in. in diameter, which drives the drum, 5ft. 6in. in diameter; average load 8 tons. My difficulty is with the teeth of the pinion which gears in the drum, and which keeps giving way. Is the pinion too small, or what is the cause? What would be the strongest way to replace a tooth when one gets broken?—A Subscriber.

Answer.—In answer to "A Subscriber," I may state that the eight tons of load on the inclined plane of 45° puts such strain on the teeth of the spur wheel on the drum shaft as nearly to exceed their power of resistance, leaving a very small margin indeed for shocks and emergencies of working. The teeth of this wheel and its pinion suffer about 2¼ times the amount of strain which the teeth of the other pair of wheels sustain; while the strength of the teeth of each set of wheels is much about the same. In consequence of a difference of shape in the teeth of the small pinion, which gears into the drum spur, in order that the small and large wheels may run smoothly together, the pinion teeth are still further weakened, and must in consequence fail on a slightly increased strain being by any means brought about. These two wheels are much too weak for the work they have to perform, and ought to be replaced by wheels of say 2in. or 2⅛in. pitch, and 5½in. or 6in. broad. Shrouds should be cast on both sides of pinion, or shrouds up to pitch line on both pinion and spur wheels. W. A.

Rivet Furnace.—Can any reader of your valuable paper give me some idea of an economical rivet-heating furnace for two stationary riveting machines?—P. H.

Answer.—One of the best rivet furnaces now in use is the one heated by "Lyle's" patent. I do not know patentee's address, beyond it being Paisley. It is a kind of gas oil apparatus to an ordinary two-deck furnace, about which there should be no trouble, and little expense, and suitable for two machines. —Straightedge.

Marine Crank Shafts.—In your issue of the 3rd inst., you give Lloyd's and Board of Trade rules for crank shafts. Enclosed is a sketch of a shaft at present running in a pair of H.P. engines, and of a type which is very common in launch and small tug work, but to which the rules are scarcely applicable, as this shaft has no bearing between the cranks. A simple formula, or "rule of thumb," by which to calculate the strength of shafts of this description, would be an acceptable addition to the rules already supplied by you. What is the maximum pressure that could be safely allowed in this case, the material being iron of fair quality, the cylinders each 11in. diameter, and the stroke 17in., angle between crank 90°?—C. B. F.

Note.—The enclosed sketch shows a shaft with two sweep cranks at right angles, as stated. The centres of the cranks are 2ft. apart. There are no centre bearings, but there is one outside each crank, the centres being 3ft. 5in. apart. The bearings are 5¾in. long and 3¾in. diameter. The length of the crank pin is 5in., and the diameter $4\frac{3}{16}$in. The cheeks of the cranks are 3in. thick, and the diameter of the shaft between the two cranks is 4¼in.—Ed.

Blisters in Furnace Plates.—Would any of the readers of *The Practical Engineer* be so kind as to tell me the cause of a blister which sometimes comes in corrugated furnaces of marine boilers. I have seen new ones after only one trip go the same way, which was thought to be unsafe, and new ones had to be put in in their places.—Flying Childers.

Answer.—Blisters in steel plates were described a few weeks ago. Blisters in iron plates are due to slag or cinder getting into the bloom when piling, which expands in area during rolling, and when the plates are submitted to such severe treatment as corrugating, the layers are further separated, and the blister or lamination, though at first invisible, soon reveals itself after a few weeks working.—Straightedge.

Will some reader of your valuable paper kindly favour me with answers to the following questions?—R. W.

(1.) Give an expression for the thickness of the shell of a cylindrical boiler, the tensile strength of which is 30 tons per square inch, diameter of boiler being 5ft., and pressure of steam 30lb. above the atmosphere. (2.) Show by sketch how the steam is cut off before the end of the stroke is reached, so as to work expansively—first with the ordinary slide valve, and second with Cornish valves, and what should be the terminal pressure if steam at 80lb. be cut off at one-fifth of the stroke? (3.) Describe with a sketch a Pulsometer pump, and describe its action. (4.) What is the use of an air vessel in connection with a force pump?

Answer.—(1.) If D = diameter of shell in inches = 60.
t = thickness of shell in inches.
d = diameter of rivets.
H = pitch of rivets in inches.
S = tenacity of material in tons per square inch = 30.
P = bursting pressure of shell.

The following equation expresses the relation between the various quantities:—

$$P \times H \times D = (H - d)\, 2\, t \times S \times 2240$$

$$\text{Whence, } t = \frac{P \times H \times D}{(H - d) \times S \times 2240 \times 2}$$

(2.) Given the point of cut off, the kind of valve employed has nothing to do with the terminal pressure, which is simply inversely as the volume; so that if the steam be expanded five times, the absolute pressure at the end of the stroke is one-fifth what it was at the beginning.

$$\text{Therefore terminal pressure} = \frac{80 + 15}{5} = 19\text{lb.}$$

(3.) We have hardly space to deal with this question, but if you will write the Pulsometer Company, 9, Elms Ironworks, London, S.W., they will probably supply you with an illustrated circular giving every information.

(4.) The air vessel acts as an elastic cushion, and prevents the violent shock which would otherwise be experienced at each stroke of the pump, in consequence of the momentum of the water.—Ed.

Working Drawings.—Many thanks to "J. R." for information regarding working drawings. I quite see how the arrangement is now, but has not "J. R." made a mistake in saying the transverse distance bars pass through the bottom holes of base plate; ought it not to be through supporting strap and columns only?—Constant Reader.

Navy Electrician.—Could you or any of your numerous readers give me any information as to the requirements of electricians in the Navy, and how one who has a good knowledge, both practical and theoretical, of electric lighting may become one.—T. H.

Drawing of a Pullman Car.—Could any reader inform me where I could get a working drawing of a Pullman car and a railway carriage?—E. P. S.

Smoke-consuming Furnace.—Can any of your readers give me the address of the makers of Thompson's smoke-consuming furnace?—J. E.

Setting Corliss Valves.—Would you, or any of your readers, inform me of the method of setting the above, as made by Ralph Ogden, of Ashton-under-Lyne? A description of the above engine appeared in your issue of May 6, 1887.—Corliss.

Book on Differential Wheels.—Can any reader inform me where I can obtain a copy of a book on wheels which was published by a Mr. White in the early part of the present century? The writer, I believe, was awarded a medal by Napoleon I. for a peculiar arrangement of differential gear designed by him, and which forms the leading illustration in the book. I mention this fact as it may assist in identifying the book, and I am not quite sure about its title or the spelling of the name.—Differential.

Cement for Brass.—Will you or some of your numerous readers kindly give me a recipe for or the name of the best manufactured cement for brass? I want to attach brass rings to the outside of a brass cylinder by means of cement.—Marine.

Repairs to Waterwheel.—Can any of your readers inform me how to put a segment on a waterwheel, and three pieces of the shrouds, and true the wheel? It is an iron wheel, with iron arms and cutters. Is there any book on this subject?—One in a Fix.

Marine Engines.—Will some engineer kindly inform me the way sea-going engineers take lead, and accept information respecting journal brasses? What thickness or clearance is usually allowed for top and bottom ends? How are thrust bearings with collar adjusted.—Ignorant.

Starting Gear.—A sketch and description of "Brown's steam and hydraulic starting gear" would be appreciated by Shiny Boots.

Moment of Inertia and Radius of Gyration.—The meaning of these expressions, and an explanation of the uses of the formulæ, would be valued by Shiny Boots.

TO CORRESPONDENTS.

Price of Cantor Lectures.—In answer to "Finsbury Student," we believe, speaking from memory, that the price of Professor Perry's Cantor Lectures on Hydraulic Machinery is 2s., but you will get exact information by writing the Secretary of the Society of Arts, John Street, Adelphi. We note your remarks as to the price of Mr. Blain's book. With regard to the Examination Papers, it is a question whether the demand upon our space will permit us to deal with them.

Engine Attendant.—In answer to "J. S.," there is no special course to be followed to qualify a man for the post of engine attendant. You should render yourself as familiar as possible with the working of engines and boilers by carefully reading the literature on the subject, and in this respect you may learn much from our pages. Before being entrusted with an engine, however, you would probably have to serve as a fireman, and prove your capacity for the higher post.

Inspector of Mines.—The appointment of inspector of mines is, we believe, in the hands of the Home Secretary. We are not sure that it depends at all on any examination. Your best course would be to write direct to the Home Office.

MISCELLANEA.

To Clean Old Files.—To clean old files, soak the file in raw muriatic acid for twenty-four hours.

The Lifeboat Institution.—Up to December 31st last, the Royal National Lifeboat Institution had been instrumental in rescuing, since its establishment in 1824, 33,243 persons.

Statue to John Elder.—On Saturday week, a statue erected at Govan to the memory of the late John Elder, the distinguished marine engineer, was unveiled by the Marquis of Lothian. The statue, which is of bronze, and 10ft. high, is by J. E. Boehm, R.A.

Shipbuilding Contract.—It has just been stated that a contract has been placed with a Greenock shipbuilding firm for the construction of four twin-screw steamers of about 1,000 tons each, for trading between China and Australia.

Stoppage of the Preston Dock Works.—On Saturday, July 28, 1,000 men, who have been employed for nearly four years on the Preston Dock and Ribble Navigation Works, were discharged in pursuance of the decision of the Select Committee of the House of Commons.

American Duty on Forgings of Iron and Steel.—It has been decided that the duty of 2½ cents per lb. on forgings of iron and steel or forged iron, of whatever shape or in whatever stage of manufacture, &c., does not apply to forgings of *steel alone*, but only to forgings which are composed of both materials, or of iron alone.

A German Dynamite Gun.—The French papers state that experiments with a pneumatic dynamite gun of German design were recently carried out at Kiel. The gun, which has a calibre of 12in., and is 75ft. long, was fired at an old hulk situated 2,111 yards from the muzzle. The blank shells were first fired to get the range, and afterwards two charged shells containing 598lb. of nitro-gelatine, which completely destroyed the vessel, breaking it in two.

A Magnesium Powder Lamp.—A method of obtaining a continuous light from burning magnesium has been invented by Dr. H. G. Piffard, whereby the metal is burnt in the form of powder. A continuous current of compressed air or oxygen is made to blow a jet of very finely powdered magnesium in an even and thin layer into an alcohol flame; thus producing an enormous magnesium flame of high actinic power.

The Wreck Register.—The wreck register for the year ended June 30th, 1886, recently published by the Board of Trade, shows that in the year in question there were 3,596 vessels which met with accidents on the coast of the United Kingdom. This number is below that of the preceding year by 168 cases. The number of lives lost, as a result of these casualties, was less by 82, the total having fallen from 478 to 396.

Failure of Railway Axles.—Of the 281 axles which failed on our railways last year, 161 were engine axles, 145 crank or driving, and 16 leading or trailing; 20 were tender axles, 3 were carriage axles, 94 were wagon axles, and 3 were salt van axles; 53 wagons, including the salt vans, belonged to owners other than the railway companies. Of the 145 crank or driving axles, 82 were made of iron and 63 of steel.

Proposed International Exhibition at Leeds.—At a meeting of the Leeds Town Council, held on the 2nd inst., a committee was appointed to report on the feasibility of holding an international exhibition at Leeds in 1890. The Mayor stated that Mr. Lee Bapty, manager of the International Exhibition at Brussels, had been in communication with him on the subject. It was stated that the only exhibition ever held in Leeds of any great importance was in 1875. That exhibition realised £32,000, the profits on which were just over £7,000. Since the year 1875 the population of the borough had increased by 60,000 or 70,000, and there had been a corresponding increase in the population of the surrounding districts.

Railway Accidents.—The general report to the Board of Trade on the accidents which have occurred on the railways of the United Kingdom during 1887 is issued. The total number of persons killed in the working of the railways was 919, and of injured 3,590. Of these, 121 persons killed and 1,297 injured were passengers; but of these only 25 were killed and 538 injured in consequence of accidents to or collisions between trains. The deaths of the remaining 96 passengers and the injuries to 759 are returned as due to a variety of causes, and especially to want of caution on the part of the individuals themselves. Of the remainder, 422 killed and 2,075 injured were officers or servants of the railway companies or of the contractors. Of suicides there were 70; of trespassers, 203 were killed and 114 injured; of persons passing over the railways at level crossings, 63 were killed and 35 injured; and of other persons from miscellaneous causes, 40 were killed and 69 injured. In addition there were 58 persons killed and 4,157 injured from accidents on their premises not connected with the movement of railway vehicles.

SELECTED PATENTS.

APPLICATIONS FOR LETTERS PATENT.

July 27th.

10861 Peroxide of Iron and Sulphate of Magnesia, J. Shaw, Newcastle upon-Tyne.
10872 Shipping Coal, J. Fielding, Gloucester.
10878 Supplying Fuel to Furnaces of Boilers, S. Hanson, London.
10881 Construction of Locks, J. Chandler, London.
10883 Oil testing Machines, W. S. Boult, London.
10884 Valve Gears, W. P. Thompson, London. (R. Dörfel, Austria).—[Complete Specification.]
10885 Apparatus for Condensing Steam, J. Newton and D. A. Quiggin, Liverpool.
10887 Electric Cartridges and Primers, S. A. Day, London.
10890 Motors, W. Wynne, London. (J. Beduwé, Belgium.)
10891 Machines for Corrugating Cylinders, S. Pitt, London. (T. F. Rowland, United States.)—[Complete Specification.]
10894 Ball Valves, J. W. Broadley, London.
10900 Electric Alarm, A. Siegmann, London.

July 28th.

10904 Electric Batteries, R. Sauerwald, London.
10917 Connecting Ends of Rails, T. B. Sharp, Smethwick.
10918 Cocks and Valves, W. Reeves, Birmingham.
10923 Wheels, Pulleys, and Sheaves, J. Stead, Manchester.
10926 Locking Nuts, G. Slater, Sheffield.
10929 Magneto-Electric Generators, E. Cox-Walker and A. A. C. Swinton London.
10932 Ships' Power Stearing Gear, J. H. Amour, Glasgow.
10935 Condensing Steam, &c., J. Newton, and D. A. Quiggin, Liverpool.
10936 Automatic Fire Sprinklers, J. C. Hudson, London.
10941 Lighting Railway Trains by Electricity, I. A. Timmis, Westminster.
10943 Variable Automatic Cut-of Mechanism for Fluid-pressure Engines, G Stones and J. Stones, London.—[Complete Specification.]
10950 Marking or Cutting Ellipses, C. H. Willmore, London.—[Complete Specification.]
10951 Paddle Wheels, P. Molnar, London.—[Complete Specification.]
10952 Dynamo-electric Machines, L. Simon, M. Pyke, and H. T. Barnett, London.
10954 Dynamo-electric Machines, E H. Geist, London.—[Complete Specification.]
10958 Motive Power, A. Gillot and F. Gillot, London.
10962 Utilising the Force of Running Water, F. Purdon and H. E. Walters London.
10964 Blowers, Pumps, Engines, and Meters, H. Skinner, London.

July 30th.

10971 Steam Engines, J. Hoyle and J. Harrison, Manchester.
10979 Water Meter and Waste Preventer, J. Thorp, Whitefield.
10983 Engine Adapted to Tramcars and Locomotives, E. F. Piers, Manchester
10984 Gas Engines, E. F. Piers, Manchester.
11019 Electric Bells, W. Moseley, Peckham.
11022 Covering Iron with Lead, W. R. Lake, London. (F. K. Velthuysen and Co Germany.)
11023 Railway Sleepers, J. Lambert, London.

July 31st.

11031 Governor, A. B. Wilson, Belfast.
11035 Packing for Steam Pistons, J. Thomas, Newcastle-upon-Tyne.
11038 Steam Pumps, J. Thomas, Newcastle-upon-Tyne.
11039 Machinery for Moulding Sheet Metal, &c., D. Smith, jun., Wolverhampton.
11041 Thread-cutting Dies and Stocks, H. J. Allison, London. (H. R. Cassel United States.)—[Complete Specification.]
11043 Gas Motor Engines, J. R. Wilson, Sunderland.
11044 Clutches, J. D. Westgate, London.
11045 Motive Power, J. T. Dawes, Liverpool.
11046 Spherical Chamber Rotary Blowers and Pumps, R. J. Dawson, Sheffield.
11051 Punches and Punch-holders, J. S. Taylor and T. W. Challen, Birmingham.
11056 Boiler Chimneys, G. Forbes, London.
11064 Gas Stoves, H. P. Lavender, London.
11067 Hydrocarbon Engines, J. Roots, London.
11073 Drums for Cable Railways, J. Walker, London.—[Complete Specification.
11078 Thermal Syphons, J. Gamgee, London.
11079 Railway Spikes, H. Greer, London.—[Complete Specification.]
11082 Transmitting Electrically Autographic Messages, P. A. Newton, London. (E. Gray, United States.)—[Complete Specification.]
11092 Combination Steam Engine, G. M. Capell and J. S. Raworth, Middlesex. [Complete Specification.]
11100 Vehicles Propelled by Electricity, J. Kincaid, London.
11101 Hot-air Engine, P. J. Vermand, London.

August 1st.

11115 Reducing the Pressure of Steam or other Gas, J. J. Pearson and T. H. Taylor, Newcastle-upon-Tyne.
11118 Taps or Valves, J. W. Jones, Manchester.—[Complete Specification.]
11129 Taps, Cocks, and Valves, D. McCallum and T. S. McCallum, Newcastle-upon-Tyne.
11141 Motor, G. Sellers, London.
11151 Condensing Steam, J. Newton and D. A. Quiggin, Liverpool.
11160 Steam Boilers, G. F. Redfern, Finsbury. (A. Lagrafel and J. d'Allest, France.)
11164 Generating and Superheating Steam, T. H. Davies, London. (A. Young, Hawaiian Islands.)

August 2nd.

11171 Taps, R. C. Sayer, Bristol.
11173 Combustion in Steam Boilers, Furnaces, and Flues, A. Francis and E Manbré, Liverpool.
11174 Electrically Lighting Railway Trains, T. Parker, Manchester.
11181 Cutting Tools, T. Taylor, Manchester.
11182 Motive Power, F. S. Harwood, Norfolk, and H. G. Cheesman, Doncaster.
11183 Furnace Bar, Y. J. Hamilton, Dublin.

PUBLISHERS' ANNOUNCEMENTS.

BACK NUMBERS of "The Practical Engineer," from the commencement, can be obtained at either of our offices in London or Manchester, or by order of any Newsagent.

Vol. I. (bound), containing Nos. 1 to 44 inclusive, from March to December, 1887, price 6s. 6d., can still be obtained by order from any Newsagent, or will be forwarded, carriage paid, from either of our offices on receipt of the amount by postal order or stamps.

Numerous complaints having been made to us by Subscribers of the difficulty they experience in obtaining copies of the *Practical Engineer* in certain districts, we have to state that the Journal can be obtained by any Newsagent through the ordinary trade channels, and no difficulty should therefore exist in obtaining copies by order of any Newsagent.

For the information of the trade, we may state that copies can be obtained from either of our Offices in London or Manchester, or from any of the following wholesale houses.

W. H. SMITH & SON, Strand, London.
W. H. SMITH & SON, Blackfriars Street, Manchester.
JOHN HEYWOOD, 11, Paternoster Buildings, London, and Deansgate, Manchester.
ABEL HEYWOOD & SON, Oldham Street, Manchester.
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GEORGE BROMBY, 26, Charles Street, Hull.
EDWARD KING, 37, Greyfriars Lane, Coventry.
&c., &c., &c.

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EDITORIAL NOTICES.

All communications for the Editor of this Journal should be addressed to 6, Victoria Station Approach, Manchester.

Communications intended for insertion in the current week's issue should reach us not later than Tuesday Evening.

We cannot undertake to return rejected manuscripts or drawings unless accompanied by a stamped and directed envelope.

Contributors are requested to write on one side only of the paper. Sketches should be sent on separate sheets.

TO ADVERTISERS.

Advertisements intended for insertion in the current issue should reach us on Wednesday morning at the latest.

THE
PRACTICAL ENGINEER.
AUGUST 17TH, 1888.

SPEED OF LOCOMOTIVES.

THE recent acceleration of speed on the London and North-Western and the Great Northern Railways raises afresh the question of the limit of velocity in locomotives. When George Stephenson said there was no limit to the speed of the engine "provided the works could be made to stand," he overlooked the resistance of the exhaust, probably because at that time the rates of travelling were not sufficiently high to direct particular attention to this point.

The resistance to the flow of fluids varies as the square of the velocity; hence it will be seen that on this ground alone the resistance of the exhaust increases in a much higher ratio than the speed of the engine. But there is yet another point to be considered. At the higher speed the pressure of the steam must necessarily be higher, and therefore there will be a greater weight of steam to be got rid of at each stroke. There is, of course, with this greater weight, a greater pressure to effect the discharge, and so *in point of time* these may balance each other, but still the resistance or back pressure against the piston must be increased.

The new express now running between London and Edinburgh must while running make an average speed of over fifty miles an hour, and, comparing this with forty miles, the resistance of exhaust would be increased in the ratio of 25 to 16, or more than 50 per cent. As in some parts of the run much higher rates of speed are reached, the exhaust resistance will in reality be increased in a much higher degree. In building new engines larger exhaust passages may be obtained, but to this also there is a practical limit soon reached.

It is evident that it must be sought to reduce to a minimum the quantity of steam to be discharged at each stroke, and in existing engines the only method of doing this is to be found in using higher initial pressure and a greater degree of expansion, but in doing this we are increasing the maximum strains on the machinery beyond those which it was originally designed to resist.

The frictional resistance of the atmosphere also varies as the square of the velocity, and as this at ordinary speeds amounts to about one-half of the gross resistance, it is easy to see that the power required increases in a much more rapid ratio than the velocity, and in fact, on the basis stated, would increase as the cube—that is to say, to double the speed, four times the amount of energy would be required on account of the additional atmospheric friction, and twice the amount on account of the increased velocity. Thus the expenditure of power at the higher speed would be eight times as great as at the lower one. Such an increase of power, of course, means greater traction and heavier engines, and these again mean greater resistance.

The economical limit will also have an important bearing on this question, for these increments of speed will entail a correspondingly increased expenditure of fuel; and considering the very few stops that can be made on the journey, the traffic by trains of this class must necessarily be restricted in quantity, and the returns therefore low in proportion to the working expenses.

As the necessity for higher speeds of travelling arises, as in the past, so in the future it will have to be met by new engines, especially designed, the salient characteristics of which are indicated by the difficulties to be overcome. It has been shown that the quantity of exhaust steam must be minimised, and also the speed of the piston in relation to that of the engine, so that the velocity with which the exhaust steam is driven through the exhaust port may be as low as possible. To attain these ends the wheel diameter will require to be increased in proportion to the stroke, and a higher degree of expansion used, and in this latter point there would seem to be great scope for the compound engines. The higher degree of expansion, of course, indicates increased initial pressure, and increasing the wheel diameter involves a higher total mean pressure on the piston and heavier machinery generally, and all these matters must be weighed in considering the advisability of adopting the higher rates of travelling.

There is yet the question of safety before us. In the abstract, high speed does not necessarily enhance danger, but practically the ordinary precautions against accident must be more carefully taken in the circumstances under contemplation. The danger which most obviously increases with increasing speed is that of derailment in rounding curves, and, rationally speaking, this is to be met by increasing the superelevation of the outer rail; but in this there is involved an inconvenience if the slow traffic runs on the same rails with the fast, for the superelevation demanded for the quickest trains will cause the wheels of the slower ones to grind against the inner rails of the curve. On the other hand, if guard rails are relied upon to hold the fastest trains, the wheels of those trains will grind against the guard rails; so there seems no escape from the condition that, if very fast trains are to become general for express traffic, two sets of roads must be used, one for fast and the other for ordinary service. On these points, however, the Board of Trade may possibly soon have something to say.

IRON TRADES EMPLOYERS' ASSOCIATION.

The Sixteenth Annual Report of the Iron Trades Employers' Association, while admitting the signs of improvement so far as the quantity of work placed on the order books of engineers and shipbuilders was concerned, refers to the great stress of competition in every department of the iron trades, which grows more active, and keeps prices at a point which, except in special cases, makes business altogether unprofitable, and not unfrequently attended with actual loss. Referring to the attitude taken by the trade unions upon one or two questions which have recently been made prominent, and may before long be forced more directly upon the attention of employers, the committee state that with regard to the wages question there was evidence that, as the labour market had recently been a little more stimulated, the men in many districts had pressed for and obtained advances which amounted to a full or partial restoration of the rates paid in 1885. There had been, however, nothing in the state of trade, so far as profits were concerned, to justify such advances; prices had shown no improvement, and it had been shown that after a long period of only partial employment a keen competition was increasing on all hands, whilst in many cases there was a tendency towards a fall in prices rather than an advance. With one exception, no serious or long-continued difficulty had disturbed the relationship of workmen with the members of the association during the past official year. In some cases where advances were not immediately given the men had left work pending such settlements as had been eventually made, but no permanent expression of ill-feeling had arisen between employers and workmen. The report deals at some length with the work of the Parliamentary Committee during the year, which had neither been light nor unimportant. The Rating of Machinery Bill and the Bill to amend the Employers' Liability Act of 1880 are particularly referred to. With regard to the former, it is pointed out that the funds of the association had been severely taxed year after year in the promotion of a measure of bare justice to all users of machinery; and the committee who were responsible for this report expressed the hope that neither their successors in office nor the members of the association in the several districts would allow the matter to rest until they had secured the equity they had a right to look for from Parliament. With regard to the Bill to amend the Employers' Liability Act of 1880, the General and Parliamentary Committees of the association had not been alone in their opposition to the bill in question. The Mining Association of Great Britain, the British Iron Trades Association, the Agricultural Engineers' Association, the Locomotive Manufacturers' Association, the Railway Rolling Stock Manufacturers' Association, the National Association of Master Builders, the Manchester and Oldham Chambers of Commerce, and other important organisations, had all made common cause in their united efforts to secure such modifications in the provisions of the bill as would make some of its most objectionable features less onerous to employers, and not unjust or inequitable to their workmen.

THE CHANNEL TUNNEL.

In a report on the state of the Channel Tunnel made to the Board of Trade by Major Marindin, R.E., one of its inspecting officers, and which has been published as a Parliamentary paper, it is stated that the length of the workings is practically the same as at the date of the last inspection in December, 1886. Eight inches of chalk has been cut since that date, but this had only been done with the express sanction of the Board of Trade, in order to permit of the machinery being kept in proper order. The length of the experimental tunnel is now 2,102 yards 8 inches. The timber sheeting of the tunnel in places has had to be renewed, owing to dry rot, but, with this exception, it is reported to be in the same condition it was eighteen months ago, except that it is, if anything, rather drier. To keep down the water which collects, the pumps are worked twice a week for about three hours. The amount which accumulates, however, is very trifling, being only about 440 gallons in 24 hours. The ventilation, whenever necessary, is carried out as hitherto by means of compressed air.

COPPER STEAM PIPES FOR HIGH PRESSURES.—III.

(Concluded from page 382.)

In order to ascertain how deposited copper behaves as compared with solid drawn and ordinary sheet copper, and how its strength and ductile properties are affected by the action of heat, such as is contained in steam pressures that are now common, I have had a series of experiments made, the results of which are given below.

Table D.

TABLE SHOWING EFFECT OF TEMPERATURE IN DIFFERENT DESCRIPTIONS OF COPPER.

Mark on Specimen.	Thickness.	Breadth.	Area.	Total load in tons.	Tons per square inch.	Percentage of Loss.	Temperature.	Remarks.
	..	..	..	..	..	..	60°	Cold.
P 1	·237	2·0	·474	6·80	14·33	..	60°	,,
P 2	·237	2·0	·474	5·65	10·66	26%	390°F.	Rolled sheet copper.
P 3	·237	2·0	·474	5·00	10·55	26%	390°F.	
	..	..	..	..	..	..	60°	Cold.
S 1	·192	2·0	·384	7·70	20·0	..	60°	,,
S 2	·195	2·0	·390	5·55	14·23	25·2	390°	Solid drawn copper.
S 3	·194	2·0	·388	6·10	15·7	..	390°	
	..	..	..	..	24·0	..	60°	Cold.
T 1	·179	2·0	·358	5·50	15·35	..	390°	
T 2	·179	2·0	·358	5·25	14·65	..	390°	Electro-deposited copper.
T 3	·179	2·0	·358	5·45	15·2	..	390°	

The specimens were immersed in an oil bath while they were in the testing machine, the temperature of the oil being maintained by a gas flame; and by this means the specimens were pulled asunder at the temperatures given, which correspond with the temperature of steam at 200lb. pressure.

The results of these experiments are embodied in the preceding table, and are very interesting. The electro-deposited copper, it will be seen, as well as the solid drawn copper, stood about 15 tons per square inch, while cold rolled sheet copper broke at about 10½ tons, at the temperature of 390 deg. Fahr.

Of the nine samples which had been cut across the brazed joint, the mean tensile strength per square inch was 10·53 tons; but they varied in strength from 8·59 tons up to 12·32, or about 40 per cent—say 20 per cent above and 20 per cent below the average.

The fourteen samples that were cut clear of the brazing broke with a mean tensile strength of 11·81 tons per square inch, the variation ranging from 10·19 tons to 13 tons per square inch, or from about 10 per cent above to 10 per cent below the average.

Similarly comparing with the experiments made by me at the time of the Elbe explosion, the mean of four samples of sheet copper, at temperatures varying from 300° to 370° Fahr., was 9·93 tons.

Other experiments also go to show that ordinary sheet copper cannot be accorded a breaking strain of more than about 10 tons per square inch at the temperatures of high-pressure steam, apart from the danger and uncertainty arising from brazing, which was so disastrously exemplified in the case of the Elbe and also the s.s. Lahn. In the case of the electro-deposited copper, as also in solid drawn copper pipes, these experiments indicate a breaking strain at these temperatures of about 15 tons per square inch, or an increase of 50 per cent, and an absolute freedom from the dangers of brazing. This is a step in advance, for which I am sure marine engineers will be grateful, and it comes none too soon, for our increasing high pressures have here discovered a weakness and danger that was bound to cause anxiety.

I find solid drawn pipes are now being made of larger diameter than hitherto, and I am not aware what the limit of their process of manufacture can go to: at any rate, there is no limit to which the diameters of the electro-deposited pipes can be made. Many other advantages are claimed for these electro-deposited pipes which I have not investigated, but so far as steam pipes are concerned, it is obvious that absolute uniformity of density, thickness, and tensile strength, and true circular section (all of which are important qualities), can be obtained.

It is also established that copper deposited under a burnisher can be varied in tensile strength from the ordinary granular form to a material having high tenacity, and as it obviates the necessity for the steam pipes being put into the fire for brazing purposes, the strength and safety at high-steam temperatures may be still further increased.

THE MANUFACTURE OF ALUMINIUM.

The production of aluminium at a price which would bring it into successful commercial competition with other metals, so as to render it available for ordinary industrial purposes, has been a problem for metallurgists and chemists for a long time, though it now appears to be within reach of practical realisation. With only one-third the specific gravity of iron or steel, aluminium, as is well known, possesses remarkable strength and ductility, in addition to which it possesses the rare virtue of non-liability to corrosion. It has also the merit of imparting to other metals, when alloyed in small quantities, qualities of tenacity and malleability that they would not otherwise possess, and hence alloys of aluminium have come to be used in the arts to a considerable extent.

The great cost involved in the production of aluminium has, however, retarded its development up to the present time. It is estimated, indeed, that not more than 50lb. per day have hitherto been produced, almost entirely in France, and by the Deville process, so that the metal has been more of a metallurgical curiosity than anything else.

About seven years ago Mr. H. Y. Castner, of New York, commenced experiments in that city with a view to improve the Deville process and cheapen the cost of aluminium by reducing the cost of producing the sodium from which it is obtained. Two years since Mr. Castner erected experimental works at Lambeth, where he succeeded, after nearly eighteen months of further experimentation, in satisfying a number of scientists and others that he could produce sodium at one-fifth and aluminium at one-third of the cost previously incurred. A company was thereupon formed in order to take up and work the Castner patents.

In October last the foundation stone was laid of new works at Oldbury, near Birmingham, for the production of both sodium and aluminium on a large commercial scale; the works are now virtually completed, and the successful manufacture of these products was commenced about a fortnight ago. The works are divided into four departments, namely—(1) the manufacture of sodium under the Castner patents; (2) the manufacture of chlorine by the Weldon process; (3) the manufacture of the double chloride of aluminium and sodium by the Castner process; and (4) the reduction of the double chloride by sodium.

The plant for the production of sodium consists of 20 furnaces, of large size, each capable of producing 50lb. to 75lb. of sodium per day, which is just about twenty times as much as the total quantity of sodium hitherto produced in this country.

The materials employed are caustic soda and carbide of iron, which are melted at a temperature of about 800 deg. Cent. for about an hour and a half, during which time the sodium is distilled into small iron condensers, whence it is cast into blocks of about 2lb. each. About 6lb. of caustic soda and 5lb. of carbonate are used per pound of sodium produced.

In the next section of the works the manufacture of the double chloride of aluminium is effected by the process of passing chlorine gas over a mixture of alumina and charcoal in large retorts of special construction, heated to a high temperature, the resulting chloride being distilled and caught in condensers at the back of the retorts.

There are 60 retorts for the production of the double chloride, which have a united capacity of about 6,000lb. per day. The double chloride contains about 12 per cent of aluminium, and under treatment with sodium yields about 10 per cent of that quantity.

There are two special designs of furnaces for producing aluminium, and the company are at the present time using both, pending the determination by experiment of the one best suited for the purpose. They differ mainly in the mode of taking off the aluminium. Into each of these furnaces the charge introduced consists of 80lb. of chloride, 25lb. of sodium, and 30lb. of cryolite, which answers as a flux. This charge, after being reduced for about two hours at a temperature of about 1,000deg. Cent., gives about 8lb. of aluminium, which is within 2 per cent of being absolutely pure. The total production of aluminium is expected to reach about 500lb. per day, while the production of sodium will be about 1,500lb. daily.

It is in respect of the latter product that the Castner process claims its chief economy. Hitherto sodium has cost about 6s. per pound, whereas the Castner process enables it to be produced at 9d., and this means that in the production of a pound of aluminium the cost of the sodium required has been reduced from 18s. to 2s. 3d. The essential feature of the Castner sodium process is that a temperature of about 800 deg. Cent. and steel vessels are employed, instead of a temperature of about 1,500 deg. Cent. and a small wrought-iron tube in the old process.

Although the Castner process reduces the cost of the metal from between 40s. and 45s. to about 15s. or less per pound—or, in other words, from £4,500 or £5,000 to about £1,680 or less per ton—these prices are still too high to admit of the use of aluminium *per se* in the industrial arts on a very large scale. But it is likely to come into considerable use for alloys, and perhaps to displace some of the existing alloys used in engineering and manufacturing operations generally.

A Spiral Railway Tunnel.—The following is a description of a spiral railway tunnel in use at Messrs. Guinness's Brewery, given by Mr. S. Geoghegan, the engineer to the brewery, in the course of a paper at the recent meeting of the Institution of Mechanical Engineers, at Dublin. The radius of the spiral tunnel is 61ft. 3in., with 2·65 turns, and a gradient of one in forty. The mode of construction was as follows: The earth was excavated from the annular space between two concentric circles to the depth requisite for the lowest ring of the spiral. The sides of this annular excavation were propped, and then the side walls were built up to the top; the spaces between the walls and the sides of the excavation being filled in with concrete as the work proceeded. A strong brick arch was at the same time built spirally from the bottom to the top of the excavation separating the several laps of the spiral one from the other; and on this arch the rails were laid. The height of the tunnel is 7ft. 3in. from the rails, the width 7ft. 10in., and the thickness of arch 18in. On issuing from the tunnel at the top, the line runs out on the level of the brewery yard about 35ft. above the rail level at the bottom entrance to the tunnel.

FRICTION GEARING FOR A DOUBLE STEAM DREDGER.*

The double steam dredger No. 4 in the port of Dublin was built by Messrs. Thomas Wingate and Co., of Glasgow, in 1871, and at that date was one of the largest dredgers afloat. Both sets of dredge buckets, the hoisting gear for the ladder, and the fore and aft winches are all worked by a single-cylinder low-pressure condensing side-lever engine of 150 indicated horse power. It will be readily understood how necessary it is to be able at will to disconnect the gearing of either set of buckets from the main engine, or to raise the bucket ladders and warp the dredger about without driving the upper tumblers.

Grooved Gearing.—To meet these requirements the builders adopted Robertson's grooved frictional gearing (Proceedings, 1856, page 202). Two grooved pinions of 54in. diameter, with nine grooves cut to an angle of 40° and 1¾in. pitch, were fixed on the engine shaft, and geared into two grooved wheels of 127½in. diameter, running on intermediate shafts, but not keyed to them. Each of these wheels revolved on an eccentric gun-metal bush, embracing the intermediate shaft and turning freely on it; and by means of long levers connected with the eccentric bushes the grooved wheels could be put in and out of gear with the pinions on the engine shaft. A cast-iron driver keyed on the intermediate shaft was connected with the grooved wheel by a pin and sliding guide block, in such a manner as to allow of the eccentric motion; so that when the grooved wheel was thrown into gear it carried the cast-iron driver round with it, and thereby turned the intermediate shaft, on which was keyed a toothed pinion gearing into the large spur wheel of the upper tumbler. Thus at will either or both upper tumblers could be put in and out of gear without stopping the engine. The speed of the grooved wheels at their circumferences was about 500ft. per minute. If half the engine power was transmitted by each set of gearing, and allowance be made for the friction of the engine itself, the tangential force at the rims would be about 3,690lb.; requiring, if the angle of the grooves were 40° and the co-efficient of friction 0·18, a pressure of 7,615lb. between wheel and pinion to prevent slipping.

The dredger began dredging in Dublin in 1872, and worked on the average forty-seven weeks per annum for eleven years till 1883, when it was sunk by collision, having raised nearly 4,500,000 tons. The large friction wheels were practically worn out, and the pinions had been twice renewed and also re-turned, at a cost of nearly £300. A renewal of the rims of the large wheels, which were separate castings from the bosses and arms, would have cost at least £200. The life of the pinions may be taken as five years, and of the wheels twelve years; and these relative durations are found to be nearly proportional to the circumferences of the pinions and wheels. The cost of repairs and renewals of the grooved gearing, if the wheel rims had been renewed, would therefore have averaged about £47 per annum, or £1 per working week.

Some of the difficulties experienced in connection with this grooved gearing arose from variations in the hardness of the castings. Soft spots wore faster than the hard portions; and by degrees there was a tendency to slip at the soft spots, unless the wheels were kept in gear by very considerable pressure. As the large wheels wore down, the rim deflected between the arms; and this also caused unequal wear, which was attended by slipping of the gearing. In No. 4 dredger the pinion was wider in the face than the large wheel into which it geared, and was placed below it. The oil from the upper bearings trickled down the large wheel, and lubricated the outer grooves of the pinion.

The wear and tear of these outer grooves was therefore less than of the intermediate grooves. This led to their having a greater share of the pressure than the central grooves, and resulted in the outer faces bursting off.

In addition to the mere angle, the form of the groove is an important feature in grooved gearing. When wheels of unequal diameters work into each other, it must be borne in mind that the small wheel will wear faster than the large; and the shape of the grooves in both wheels should be such that they will remain similar in shape till the tops of the ridges begin to touch the bottoms of the grooves. As soon as this point is reached, the wheels must of course be re-turned or renewed. The practice of cutting the ribs with a uniform slope down to the bottoms of the grooves is objectionable, for, as the upper portions of the ribs wear, shoulders are formed in the sides, and on these shoulders the ends of the ribs of the adjoining wheel begin to bear, instead of on the sloping surfaces. Increased pressure has to be applied to keep the wheels in gear, and the advantages of the grooving are lost.

In 1885 and 1886, after the dredger had been raised and repaired, it was worked a short time with the same frictional gear; but the large wheels were so worn that their rims cracked in several places between the arms. After carefully considering the question of renewal, it was decided by Mr. Bindon B. Stoney, the chief engineer of the Dublin Port and Docks Board, to adopt the following arrangement.

Spur Gearing with Brake Wheels.—In place of the grooved pinion and wheel, a toothed pinion is keyed on the engine shaft, gearing into a spur wheel which runs loose on the intermediate shaft; and to the side of the spur wheel is bolted a cast-iron brake wheel. As in the original arrangement, a cast-iron driver is keyed on the intermediate shaft. At each end of the driver is hinged a T-shaped lever. To the short arms of the lever are attached with adjusting screws two steel brake bands, the other ends of which are fastened in a similar manner to the corresponding T lever at the opposite end of the driver. The steel bands thus embrace the brake wheel like a brake strap. The long arms of the T levers are connected by tension rods with bell cranks hinged at the centre of the driver; and the bell cranks are also connected with a collar sliding on the intermediate shaft and revolving with the driver. The collar can be moved backwards and forwards along the shaft by a long lever worked by a hand wheel and screw, so as to loosen or tighten the steel bands on the brake wheel. When the engine is working, the large spur wheel and its attached brake wheel revolve; and by tightening the steel bands till they grip the brake wheel, the driver and intermediate shaft are set in motion, together with the upper tumbler and its chain of dredge buckets.

The diameter of each brake wheel is 88in., its breadth 6in., and the speed at its circumference about 400ft. per minute. In regular work the steel brake bands are supposed to transmit half the engine power. Each set of gear, however, is designed of sufficient strength to transmit the maximum power which the engine can exert: that is, on the supposition that the engine may be pulled up at half-stroke with the full steam pressure and vacuum on the piston, and with only one set of friction gear in operation. In practice the brakes slip before any such stress is reached, as they are only tightened sufficiently to start the drivers and buckets.

The whole apparatus is simple and effective. Its wearing parts are accessible and easily renewed at small cost. Engineers having charge of machinery naturally take special interest in the cost of maintenance, which is sometimes overlooked by designers and manufacturers. The importance of reducing wear and tear in dredging machinery will, it is thought, sufficiently justify the foregoing description of a detail which occupies a prominent position in the working of dredgers.

THE FIRST CENTURY OF THE MARINE ENGINE.*

In various Scotch newspapers for October, 1788, there appeared an account of an experiment, which was said to be "no less curious than new." It was stated that "on the 14th inst. a boat was put in motion by a steam engine upon Mr. Miller of Dalswinton's piece of water at that place. That gentleman's improvements in naval affairs are well - known to the public. For some time past his attention has been turned to the application of the steam engine to the purposes of navigation. He has now accomplished and evidently shown to the world the practicability of this by executing it upon a small scale. A vessel 25ft. long and 7ft. broad was, on the above date, driven with two wheels by a small engine. It answered Mr. Miller's expectations fully, and afforded great pleasure to the spectators present. The engine used was Mr. Symington's new patent engine." It was further stated that a "more complete, successful, and beautiful experiment was never made by any man at any time, either in art or science. The vessel moved delightfully, and, notwithstanding the smallness of the cylinders (4in. in diameter), went at the rate of five miles an hour." It continued to ply for some days for the amusement of the projector and to the astonishment of the country people, who assembled from all quarters to witness the wonders of a "boat driven by reek." Fifty years later, that is in 1838, the Sirius and the Great Western crossed the Atlantic, both arriving at New York on the same day, April 23, the Sirius in the morning and the Great Western in the afternoon. We are thus in this year

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*Paper by Mr. J. P. Griffith, before the Institute of Mechanical Engineers, Dublin, August 1st, 1888.

*Paper by Professor Henry Dyer, C.E., M.A., read at the Institute of Naval Architects, July 25th, 1888.

1888 in a position to celebrate the centenary of the marine engine, and at the same time the jubilee of trans-oceanic steam navigation. I have no intention of entering into the various historical disputes which have taken place regarding both of the above dates. I shall simply take them as convenient starting points from which we may make a rapid *résumé* of the chief steps in the development of the marine engine and steam navigation; in fact, to take stock of the most important advances which have from time to time been made, so that a distinct idea may be formed of our present position. Such stock-taking is as necessary in different departments of knowledge as it is in business, and the visit of the Institution of Naval Architects to the Clyde, the greatest shipbuilding centre in the world, in the hundredth year of the marine engine and the fiftieth of trans-oceanic steam navigation, seems a suitable occasion for a rapid review of marine engineering. To do full justice to the task, however, would take much more time than I have had at my disposal since I was asked to undertake it, and more than you would be willing to spare on such an occasion as this. A brief outline is all that can be attempted, and even that must be to a large extent confined to Clyde practice.

It is not necessary that we should enter into the details of the development of the steam engine apart from its application to the propulsion of vessels; it is sufficient to note that in the first steam engine which was at all of a practical nature, and resembling those at present in use, namely, that designed by Papin, the boiler, cylinder, and condenser were combined in one; that the next step was taken by Newcomen, when he separated the boiler from the cylinder; while engines of the same type as those which at present exist were designed by Watt in all their essential details when he separated the condenser from the cylinder. The tendency to multiply parts still, however, continues, and instead of the steam being used in one cylinder, as it was by Watt, it is now very often used in two, three, or more cylinders, each with separate organs of admission and exhaust, and requiring a multiplication of the parts of the mechanism.

The credit for the design of the engine and boat used at Dalswinton seems to be jointly due to Patrick Miller, James Taylor, and William Symington. John Scott Russell has remarked that "the creation of the steamship appears to have been an achievement too gigantic for any single man. It was produced by one of those happy combinations in which individuals are but tools working out each his part in a great system, of the whole of which no single one may have comprehended all the workings." After a long and patient examination of the claims of each candidate, Mr. Scott Russell came to the conclusion that the art of steam navigation was the joint invention of the three men who have been named, and that to their efforts the world owes its present advantages. Similar remarks apply with even greater force to the later stages of the development of the marine engine, as to many minds seem to be due the ideas which bring about improvements, although one man may be fortunate enough to make them commercially successful. In the case we are considering the combination of the three men concerned in the work was well designed to bring about good results. Miller was a patriotic and wealthy experimentalist, Taylor a sagacious projector, and Symington an ingenious and experienced mechanic. The second steamboat was constructed at Carron in 1789 by the same three men. It was 60ft. in length, and was fitted with engines having cylinders 18in. in diameter. At the first trial the boards of the paddles gave way. They were, however, repaired, and on December 26, 1789, the experiment was repeated, and a speed of nearly seven miles an hour obtained. The boat, however, was of too slight a build to be used permanently for traffic; and as soon as the experiments were over the engines were taken out and deposited at Carron Works, and the vessel used as a pleasure boat by Mr. Miller.

The first really practical steamboat, the Charlotte Dundas, was designed by Symington in 1801, and tried on the Forth and Clyde Canal early in 1802. It was propelled by a Watt double-acting engine, turning a crank on the paddle shaft, and was able to tow two vessels, each of 70 tons burthen, a distance of twenty miles against a strong head-wind in six hours. The proprietors of the canal, fearing injury to its banks, declined to adopt the new system of towing, and we hear of nothing further having been done by Symington.

We have now to cross the Atlantic for the next developments of steam navigation. John Fitch, an ingenious Connecticut mechanic, had for many years experimented with different designs of engines, and from 1787 till his death in 1798 he built several steamboats, but in all his attempts he was unfortunate. Various other workers were busy in America about the same time, or shortly after, most prominent among whom was Robert Fulton, who, although American by birth, was Irish by parentage. At the age of twenty-one, by his own exertion, he had acquired considerable skill in mechanics and as an artist. Coming to England in 1786, he spent some time in mechanical pursuits; and arriving, as he did, just before the trials of the Dalswinton and Carron boats, his attention was naturally directed to them, and about which he collected a considerable amount of information. It was not, however, till some years later that he seriously took up the subject of steam navigation. After spending some years in England, he migrated to Paris, where many projects occupied his time, especially submarine warfare, locomotion, and explosions. In 1801 he directed the attention of Livingstone, the American Minister at the Court of France, who had himself made many experiments on the subject, to the importance of steam power in the navigation of the lakes and rivers of their own country, and the two agreed to co-operate.

Fulton went about the work in a very thorough manner, and made many experiments on the resistance of models of different kinds at various speeds, and guided by the results of these he completed a steamboat which was tried on the river Seine in the spring of 1803; but the vessel proved too weak for the heavy machinery, and it broke in two and sank to the bottom of the river. The machinery, however, was little injured, and the hull being reconstructed, a trial was made on the 9th of August, 1803, and a speed of about 4½ miles an hour attained. Disappointed in obtaining pecuniary aid from the French Government, in 1804 he crossed over to England, and ordered an engine from Boulton and Watt of 2ft. diameter of cylinder and 4ft. stroke, which in its design was a modification of the ordinary type of engine made by that firm. Fulton and Livingstone, on their return to America, constructed a vessel named the Clermont, which was launched in the spring of 1807, and employed the Watt engine to propel it. This vessel, which had many of the characteristics of the American river steamer of the present day, was larger than any steam vessel which had hitherto been constructed, being 133ft. long, 18ft. broad, and 9ft. deep. The boat on its trial ran a distance of 150 miles in thirty-two hours, and returned in thirty hours, and this, no doubt, was the first voyage of considerable length ever made by a steam vessel.

Fulton built a considerable number of other vessels immediately after the successful trial of the Clermont, and in 1812 he designed the first steam vessel of war, which was launched on 29th October, 1814. The Fulton the First, as the vessel was called, was considered of enormous dimensions at that time. The hull was double, 156ft. long, 56ft. broad, and 20ft. deep, measuring 2,475 tons. On her trial trip she steamed 53 miles in 8 hours and 20 minutes, and when her armament and stores were on board she made 5½ miles per hour. Although we cannot place Fulton among the highest class of inventors, still his name deserves to be honoured for having made steam navigation a commercial success. Among the other Americans who did much to advance marine engineering in its early days, time will only permit the mention of those of John Stevens, of Hoboken, who not only did much to improve the designs of engines, boilers, and propellers, but also of the forms of vessels; and of his son, Robert L. Stevens, who afterwards became known as the designer and conductor of the Stevens battery.

The part taken by Fulton and Livingstone in America was occupied in Britain by Henry Bell, of Helensburgh, on the Clyde, who turned to useful account the experience of Miller, Taylor, and Symington. He had the further good fortune to associate with himself an able shipbuilder and an ingenious engineer. In 1812 he contracted with John Wood, of Port Glasgow, to build the hull, and with John Robertson, of Glasgow, to make the engines of the Comet. This vessel was 42ft. long, 11ft. broad, and 5ft. 6in. deep, and the engine of three-horse power had a cylinder 11in. in diameter, with a stroke of 16in. At first she was fitted with two pairs of paddles driven by spur gearing, but this arrangement proving unsatisfactory, she was lengthened to 60ft. and fitted with a single engine, which drove a single pair of paddles. The speed attained seems to have been six miles an hour. Mr. Bell had associated with him in his experiments John Thomson, engineer, Glasgow, who, feeling himself aggrieved when Bell declined to allow him to become a partner in the speculation, got John Wood to build a vessel 51ft. keel, 12ft. beam, and 5ft. deep, which was named the Elizabeth, and made on an average nine miles an hour, and was able to eclipse Bell's Comet. The Elizabeth was thus the first remunerative steam vessel in Britain.

(To be continued.)

HOLDEN'S PATENT ASSISTED DRAUGHT FURNACE.

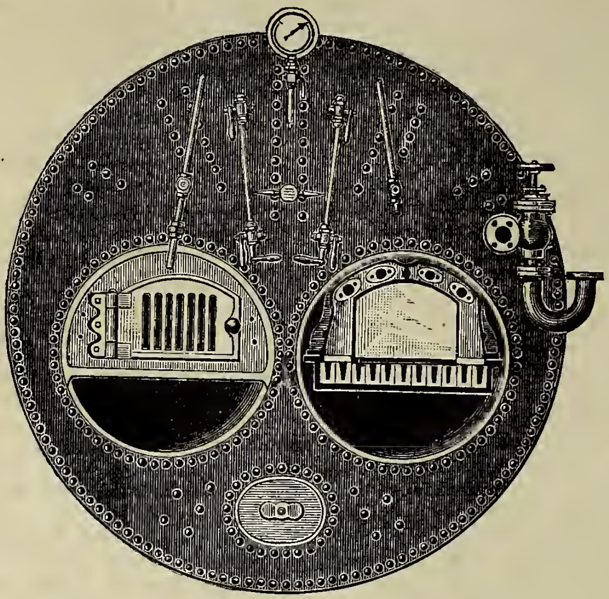

Fig. 1.—End Elevation

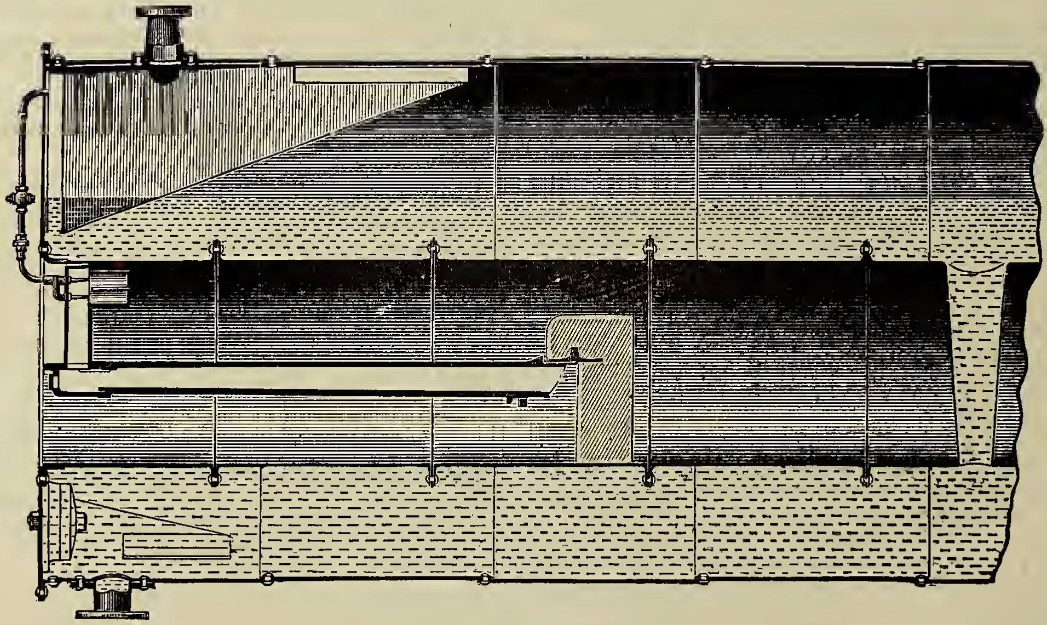

Fig. 2.—Longitudinal Section

The apparatus illustrated above represents an improved form of furnace for promoting combustion and preventing smoke, which is now being extensively adopted, and with most excellent results. The engravings show the application of the apparatus to an ordinary internally-fired boiler of the Lancashire or Cornish type. Fig. 1 is a front elevation; fig. 2 a longitudinal section; and fig. 3 a sectional plan.

The manner in which the draught is assisted and more perfect combustion secured is very simple, and will be easily understood. On reference to the illustrations, it will be seen that the firebars are cast hollow, and the air, admitted at the mouth of the ashpit, after passing under the fire, returns through the hollow bars to a small chamber beneath the dead plate at the front end in a highly-heated condition. From this chamber the air rises through a passage on each side of the fire door, and is delivered to the furnace through the four short nozzles shown in figs. 2 and 3. Situated in the chamber, and immediately behind each of these nozzles, is a small jet through which live steam is introduced, thereby setting up an induced current and delivering the air at a high velocity. As the supply of steam is controlled by a tap, it will be seen the current of air passing through the furnaces, and thus the rate of combustion, can be regulated to a nicety.

We recently had an opportunity of inspecting the working of the apparatus. The boiler to which it was applied was hard fired, and prior to its adoption the owner of the boiler had on several occasions been brought into unpleasant contact with the smoke inspector. At the time of our visit, however, it was almost impossible to tell from the appearance of the chimney that the boiler was at work, no smoke being discernible beyond a few slight puffs emitted after the charging of the fires.

It will be seen that the apparatus not only acts as a smoke preventer, but that, by means of the steam jets, the draught can be increased to a very material extent. The arrangement, in fact, has been applied with complete success to a number of steamships with the express object of forcing the draught and promoting combustion.

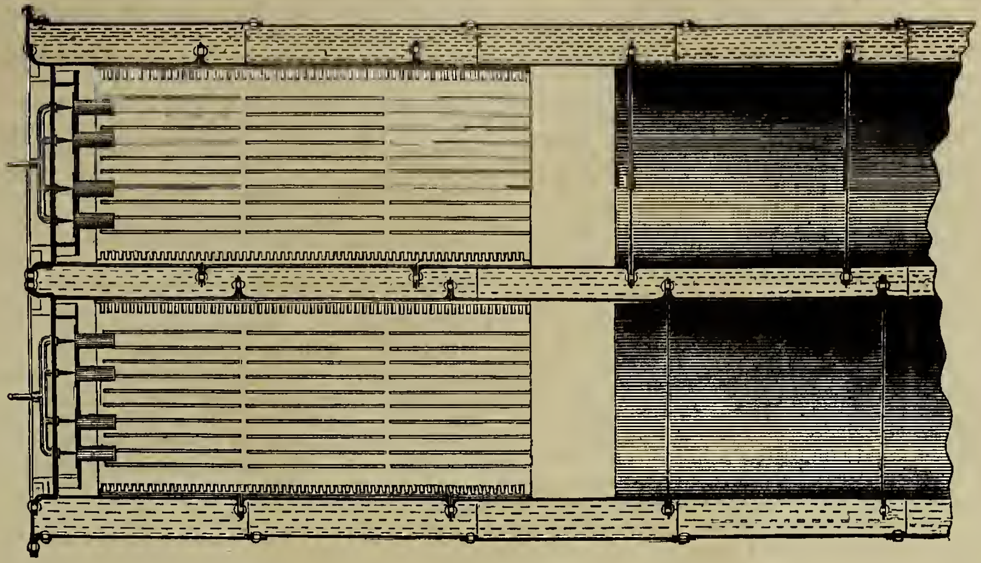

Fig. 3.—Plan.

As will be seen from the engravings, the construction of the apparatus is very simple, while its application involves no structural alterations, and it can be easily and rapidly fitted to any existing boiler either of the land or marine type. The combination of regenerative heating of the air supply with the perfect regulation of the draught enables the evaporative efficiency of the boiler to be developed to its fullest extent, while it secures at the same time perfect combustion and absence of smoke. The makers of the apparatus are the Oldham Boilerworks Company, Limited.

MOTIVE POWER BY ATMOSPHERIC EXHAUSTION.*

This system of domestic motive power, the application of which has already been noticed, has been extending in Paris, where a central exhausting station has been established in the Rue Beaubourg. The principle consists in maintaining a vacuum, averaging 67 per cent, or 20in. of mercury, but occasionally reaching to 75 per cent, or 22½in., in a reservoir serving to regulate the pressure in the pipes. The air-pump, an ordinary compressor working reversely, consists of a cast-iron cylinder, on the ends of which the suction valves and discharge valves are mounted. The piston, also of cast iron, is formed with several grooves in the circumference, the two outer grooves being fitted with indiarubber rings. These rings are pressed against the cylinder by air passing through the piston. The valves are of indiarubber. The exhaust reservoir is 49in. in diameter, 11½ft. in length. The air is discharged into a sheet-iron chimney, by which it is carried off clear of the engine-house, thus causing a slight draught, which aids the pump. Water is injected into the cylinder to obviate the rise of temperature which would otherwise occur from the compression of the rarefied air to atmospheric pressure. The pump is worked by direct connection with a horizontal Corliss condensing steam engine of 90 H.P., making 36 turns per minute, and working with an initial steam pressure of 4½ atmospheres, cutting off at one-fifth. The efficiency of the pump is estimated at 93 per cent of the power transmitted. The maximum demand for power, supposing all the motors to be at work at the same time, is 35 H.P.

It can be proved that, with a perfect machine, 1 cubic metre of air entering the main produces 13,530 kilogrammetres of work. In practice the air cylinder utilises 93 per cent of the power transmitted; of this proportion the exhaust motors in turn give a maximum of 60 per cent; the loss of head in the main is 5 per cent; lastly, the air yields only 85 per cent of its total capacity for work. The resulting coefficient is 45 per cent; and the actual work of 1 cubic metre of air is 13,530 × 0·45 = 6,088 kilogrammetres (44,034 foot pounds). To produce N H.P., it is necessary to extract $\frac{N\ 75}{6{,}088}$ cubic metres per second at the atmospheric pressure P; and making $\frac{P}{n}$ equal to the pressure in the main, the volume will be $\frac{N\ 75\ n}{6{,}088}$ cubic metres per second, or about 4 cubic yards per H.P. per minute, if $n = 4$ as it is at Paris; whence the capacity of the air cylinder may be deduced.

From the exhausted reservoir, a main is laid in the sewers or in trenches, and is provided with as many branches as necessary. A junction is made with the pipes for each subscriber, who is furnished with a special stop-cock.

The principal pipes are of cast iron, in lengths of 1 metre, and of varying diameter, 10in. and 8in. from the pumping station to the sewer, and 8in. and 4in. in the sewer or trench. They are from 0·25in. to 0·40in. in thickness. The joints of the pipes are run with lead against an indiarubber ring, and caulked in the usual way. The conduits do not exceed from 1 mile to 1¼ mile in length. Greater lengths than these induce very sensible losses of head; hence the necessity for creating a series of centres. Condensation water in the pipes is not provided against, as the water carried by the atmospheric air vaporises under the low pressure. But, on the other hand, the air, in entering the conduit, expands rapidly and falls in temperature, when the entering moisture may freeze, and clog the motors. For such a contingency the company declines responsibility.

By the secondary motors, the pressure of the air is converted into work at once utilisable by the operator. Motors of three types have been employed—oscillating, rotative, and trunk. The first has fallen into disuse, in consequence of waste by leakages. The operator simply turns a tap to start the engine, no further attention being necessary while his motor is at work. The rotative motor is specially constructed for small powers of from $\frac{1}{25}$ to $\frac{1}{6}$ of a H.P. The trunk engine is employed for powers of from $\frac{1}{3}$ to 1 H.P. The efficiency of the motors varies from 40 per cent to 60 per cent, according to the size of motor used. The number of revolutions of each motor is registered by a counter, in which a roller turns in contact with a friction-plate, at a greater or less radial distance from the centre of the plate, according to the pressure developed. Thus the variation of pressure is compensated for by the registering of a greater number of turns relatively as the pressure is augmented, and a less number as it is reduced.

The economy effected by the use of these domestic motors is exemplified by the case of a brushmaker, who works a saw and five drilling lathes. Now, with a ½ H.P. motor, five men do the work of eight employed previously, and the expenditure is 3 francs per day for the motor power, against 15 francs for three men (2s. 4½d., against 11s. 10½d.).

In another case, that of the manufacture of tortoise-shell combs, two lathes are employed, to drive which a man was formerly paid 5 francs per day of ten hours. Now, with a motor, the cost for power is only 2½ francs per day (3s. 11½d., against 1s. 11½d.).

The charge for power of from $\frac{1}{25}$ H.P. to 1 H.P. varies from 0·057d. to 0·665d. per 1,000 revolutions, or from 0·884d. to 5d. per hour.

The hygienic advantage of the exhaustion motor in promoting ventilation is obvious.

D. K. C.

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* Foreign Abstracts, Proc. Inst. C.E.

THE AIR IN COAL MINES.

At a recent meeting of the Royal Society of Edinburgh, Dr. T. G. Nasmyth read a communication on the air in coal mines. At the outset he described the condition of ventilation in coal mines 20 years ago, which was such as no miner would nowadays be asked to work in. Going on to give the results of his observations, which in the paper were recorded in tabulated form, he showed that the temperatures taken at 1,000 yards from the downcast shaft differed but little, and only in the direction of greater uniformity, from the temperature recorded in the open air. One point he noted was that it was nearly always saturated. The result of the tests for carbonic acid gas went to show that the state of the coal mines in that respect was not worse than that of the one-roomed houses and badly-ventilated factories and schoolrooms. As to the effect of the miner's occupation on his health, he gave statistics which went to show the improvement in recent years, and the comparative immunity of the miner of the present day from chest diseases. In the parish of Beith the death-rate from phthisis was 1·33 per 1,000 per annum on the average—1 01 among men and 1·72 among women—and that in a population almost wholly composed of miners. The average for 12 years showed that 43·1 was the mean age of death for miners. Summing up, he argued that the state of the air in coal mines was wonderfully good, and looking to the nature of the products that went to vitiate the air in mines, it would not be easy to insure that it would be as good as above ground. His own experience was that phthisis was not common among miners. He knew of no disease peculiar to miners, and of no disease existing in excess among them. His belief was that the conditions connected with a miner's occupation were as favourable as those of any other workmen.

WIRE ROPEWAYS.*

The aerial carrying cables employed at the Porte de France works have been adopted in many places ; and the simpler and more economical system, devised by Mr. Gourjon, lime manufacturer at Teil, may suffice in many cases, and, like the previous system, render very important services. Mr. Gourjon uses only one endless cable, moving round two pulleys in the same vertical plane, and carrying, hung at equal intervals on the lower portion, the full skips to their destination, and on the upper portion, the return empty skips. The motion imparted by gravity, or a special motor, is continuous and regular, and the tension and form of the cable remain constant. At Teil, the horizontal distance is 1,558ft., and the difference in level only $81\frac{2}{3}$ft., which necessitates a little help from the motor of the works to supplement the force of gravity. The sheet-iron baskets, hung from the cable at intervals apart of $111\frac{1}{2}$ft., weigh 110lb. when full, and travel at the rate of $5\frac{3}{4}$ft. per second. The traffic is 70 tons per day ; the cost of the installation £100, and the cost price of transport 3·11d. per ton-mile. Another cable has been set up at St. Imier, near Grenoble, for the conveyance of cement materials like the previous one, following the windings of a valley for a distance of 8,200ft. The two portions in the intervals between the pulleys at each end are supported, at the same level, by pulleys fixed to poles placed about 500ft. apart. The steel cable, made in England on the new "excelsior" system, has a diameter of only 0·67in. The installation, which cost £520, suffices for a daily traffic of 50 tons, at a cost of $3\frac{3}{4}$d. per ton-mile. A cable has been set up at Alzon, for conveying across a valley, 1,579ft. wide, the blocks of stone for the masonry of some railway works. The unhooking of the skips is effected automatically ; but some delay is caused by the stoppage of the cables for hooking on the skips. Nevertheless, 130 tons are carried daily at a cost of 14·4d. per ton, or half the cost of carriage by carts.

An endless transporting cable is being put up, with its two portions at the same level, which, passing over vertical pulleys at the end of the course, are directed at an angle of 20° to 25° on to a winding pulley, placed flat at a little lower level, facilitating greatly the unhooking and hooking on of the skips. This installation, designed for a distance of 2,214ft., and $242\frac{3}{4}$ft. of descent, will cost £440, and will enable 72 tons of cement to be carried down daily, at a slow rate, from the kilns to the works, at a cost of 2·1d., instead of $10\frac{1}{2}$d. per ton, as at present by cartage. In this case the arrival pulley, moved by gravity, will be connected with the motor of the works, for lowering or giving power, according to circumstances, and to secure always a regulation of its speed. An application of cable transport, belonging to both systems, has been carried out on an extensive scale at the blast furnaces of Vajdna-Hyniad in Transylvania. The mineral is 6 miles from the works, and the coal $13\frac{1}{4}$ miles further off ; whilst the ruggedness of the country renders the formation of a road or ordinary railway so difficult that recourse has been had to a wire ropeway, $19\frac{1}{4}$ miles long, resembling the Porte de France system in its arrangement, and the Teil system in its working. The two carrying cables are fixed at the same level ; but a great number of skips, hanging from them, follow at regular intervals, going by one cable, and returning by the other, and drawn along continuously by an endless cable to which they are hooked. The distance has been divided into eight straight sections of about $2\frac{1}{2}$ miles. The carrying cables are supported on pulleys, the others on rollers, fixed to timber uprights placed 330ft., and occasionally 660ft., and even 1,540ft. apart. As the gradient is too gentle for automatic motion, a double-grooved pulley between each pair of sections, moved by a 9 H.P. engine, sets in motion the cables of the two sections, which are wound on the pulleys. The installation cost £2,425 per mile, and the cost of conveyance is $8\frac{2}{3}$d. per ton-mile, which is decidedly cheaper than the ordinary methods of transport.

L. V. H.

METALLISING WOOD.

A process by which wood is made to take on some of the special characteristics of metal has, it is stated, been turned to practical account in Germany. By this process, which has produced some remarkable results, the surface becomes so hard and smooth as to be susceptible of a high polish, and may be treated with a burnisher of either glass or porcelain, the appearance of the wood being then in every respect that of polished metal, having, in fact, the semblance of a metallic mirror, but with this peculiar and advantageous difference, viz., that, unlike metal, it is unaffected by moisture. To reach this result the wood is steeped in a bath of caustic alkali for two or three days together, according to its degree of permeability, at a temperature of between 164 deg. and 197 deg. Fahr. It is then placed in a second bath of hydrosulphate of calcium, to which a concentrated solution of sulphur is added after some 24 or 36 hours. The third bath is one of acetate of lead, at a temperature of from 95 deg. to 120 deg. Fahr., and in this latter the wood is allowed to remain from 30 to 50 hours. After being subjected to a thorough drying it is in a condition for being polished with lead, tin, or zinc, as may be desired, finishing the process with a burnisher, when the wood apparently becomes a piece of shining metal.

SAFE WORKING PRESSURES FOR CYLINDRICAL FURNACES AND FLUES.*

There is perhaps no question relating to steam boilers in a more unsettled state than this. Several formulæ have been produced for calculating the ultimate strength of such structures to resist external pressure, but not only do they give results differing by more than 100 per cent, but the results themselves require to be divided by a variable number or factor of safety to bring them into anything like accordance with the teachings of every day experience. This will become evident by applying to flues of ordinary dimensions the formulæ most generally used, viz., Fairbairn's, and that given by the Board of Trade in its "Instructions to Surveyors."

The former, more applicable to long tubes, is generally used in the form—

$$P = \frac{CT^2}{LD}$$

P being the collapsing pressure in lbs. per square inch.
T „ the thickness of the plates in inches.
D „ the diameter of the flue in inches.
L „ the length of the flue in feet.
C „ a constant given as 806,300 in the text books, and as 375,023 by one of the Board of Trade Surveyors.

The board's formula gives the working, not the collapsing pressure ; but as it is said to give a factor of safety of 4·94, it may be converted into a formula for giving the collapsing pressure by multiplying by that number. In this form it may be stated thus—

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* Foreign Abstracts, Proc. Inst. C.E.

* Report by Michael Longridge, M.Inst.C.E., Chief Engineer, Engine, Boiler, and Employers' Liability Insurance Company.

$$P = \frac{4{\cdot}94\ C^1\ T^2}{(L+1)\ D}$$

C^1 being a constant, or rather variable, whose values lie between 90,000 and 54,000, according to various details of construction, set forth by the Board, but is 75,000 for ordinary lap-jointed flues fairly cylindrical in shape.

If we calculate the collapsing pressures of flues 33in. diameter of the lengths given below by these formulæ, we have the following results :—

Length of Flue	Ft. 30	Ft. 20	Ft. 15	Ft. 10	Ft. 5
I.—Collapsing pressure by Fairbairn's rule, with constant 806,300..............	114	171	228	342	684
II.—Collapsing pressure by Fairbairn's rule, with constant 375,023..............	55	83	110	165	330
III.—Collapsing pressure by Board of Trade rule, with constant 75,000..........	49	74	98	142	262

These are discrepancies enough to bewilder any man ; but this is not all. Suppose an engineer elect to adopt Fairbairn's formula, and to allow a working pressure of 40lb. per square inch upon a flue 30ft. long, which as he knows by experience he may safely do, thus giving a factor of safety of 2·8. Could he apply this same factor to a flue 5ft. long, and allow a working pressure of 244lb. ? I trow not. If, on the other hand, he held by the Board of Trade, and allowed a pressure of 53lb. upon the 5ft. flue, with their factor of safety of 4·94, could he apply this same factor to the 30ft. flue, and limit the pressure to 10lb. or 11lb., according as he used formula III. or II. ? To do so would be too absurd. Again, if he should decide to take Fairbairn's formula without modification for the long flues, and Fairbairn modified or that of the Board of Trade for the short flue, what is he to do with those of medium length, say 15ft. ? Add the result of the two, take the mean, and toss up for a factor of safety, or take the mean of the two factors of safety ?

Is it, then, to be wondered at that engineers prefer being guided each by his own experience to such guesswork as the application of these formulæ involves ?

Such being the present state of knowledge of the subject, the writer has thought it worth while to get out statistics of pressures at which boilers have safely worked and are at present working. It has long been evident to him, as doubtless to many others, that the form of both formulæ, of Fairbairn's particularly, was incorrect, and that whatever the deductions from experimental tubes might be, *the strength of boiler flues did not vary inversely as their length*, and that if the first power of the length were retained in the formula, the "constant" must be varied; in other words, a different formula must be made for every length of flue. He, therefore, determined to use the data in possession of the company to calculate the value of the constant for the various lengths of flues, and then to see whether an empyrical formula could not be devised to express the varying values of the "constant." To this end upwards of 8,000 of the boilers insured with the company were overhauled; all those with plain unstiffened flues and furnaces were picked out, and the dimensions and working pressures tabulated. Unfortunately, the number so selected was not so large as had been anticipated, being only 1,759, of which 1,249 were plain flues of Lancashire, Cornish, and similar boilers, and 510 the furnaces of such boilers unstrengthened for the first nine or ten feet, or the furnaces of vertical boilers without cross tubes. To these 1,759 boilers he applied the two formulæ—

$$p = \frac{c\ t^2}{D\ L} \qquad p = \frac{c'\ t^2}{D\,(L+I)}$$

in which p is the pressure stipulated in the policy, t the thickness of the plates in thirty-seconds of an inch, D and L the diameter in inches and the length in feet. The actual values of c and c' were calculated in every case, and afterwards taken out and tabulated separately for each two feet in length and two inches in diameter; the figures were then added up and the means taken and tabulated, as in the following table. Thus the number 278 at the intersection of line 30 with column 34 C gives the mean of the values of c of all the boilers with flues 30ft. and 31ft. in length, and 34in. and 35in. diameter, while the number 290 at the intersection of line 30 with column 34 C^1 is the mean of the values of c' for flues of the same dimensions.

Length of flue in feet.	DIAMETERS IN INCHES																																					
	50		48		46		44		42		40		38		36		34		32		30		28		26		24		22		20		18		16		14	
	C	C^1	C	C^1	C	C^1	C	C^1	C	C^1	C	C^1	C	C^1	C	C^1	C	C^1	C	C^1	C	C^1	C	C^1	C	C^1	C	C^1	C	C^1	C	C^1	C	C^1	C	C^1	C	C^1
36	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	192	198	294	304	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
34	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	257	264	269	277	219	225	210	217	..	..	..	..	..	..	..	..	..	..	..	..	..	..
32	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	194	202	204	213	244	253	..	..	..	..	..	..	206	213	..	..	..	..	..	..	..	..
30	..	..	..	..	..	..	..	..	..	..	..	..	381	394	308	320	278	290	265	274	238	247	297	317	..	..	218	227	..	..	..	..	..	..	..	..	..	..
28	..	..	..	..	..	..	..	..	..	..	..	..	..	..	334	353	296	307	245	255	162	167	261	273	289	299	..	..	..	..	..	..	..	..	..	..	..	..
26	..	..	..	..	..	..	..	..	..	..	287	296	..	..	325	336	237	246	210	221	243	253	197	207	232	243	..	..	..	..	..	..	..	..	..	..	..	..
24	..	..	..	..	..	..	227	233	122	127	..	..	187	195	242	251	209	217	226	236	216	227	189	197	209	218	221	233	..	..	108	112	190	197	..	..	..	..
22	..	..	..	..	..	..	..	..	..	..	..	..	..	..	210	221	205	216	210	219	176	184	181	190	195	204	162	170	..	..	..	..	..	..	..	..	..	..
20	..	..	..	..	..	..	..	..	..	..	285	298	194	205	183	191	213	226	196	206	183	193	181	191	173	184	149	153	66	70	..	..	..	..	..	..	92	100
18	..	..	..	..	..	..	..	..	..	..	98	103	192	203	201	213	176	186	166	176	163	171	160	170	177	183	220	226	143	152	..	..	..	..	..	..	..	..
16	..	..	..	..	..	..	..	..	143	153	..	..	..	..	182	194	165	175	155	165	150	162	144	153	137	147	105	112	118	125	..	..	..	..	..	..	..	..
14	..	..	..	..	..	..	..	..	..	..	62	66	157	166	130	140	144	155	150	161	144	153	122	131	129	137	113	122	115	123	75	82	102	109	..	..	..	..
12	..	..	..	..	..	..	..	..	..	..	..	..	137	152	110	119	122	133	117	127	108	117	108	117	88	96	91	100	106	115	64	75	77	83	..	..	..	..
10	..	..	..	..	..	..	..	..	..	..	..	..	..	..	109	119	99	110	100	109	94	104	99	107	92	98	85	94	60	67	93	101	..	..	..	..	..	..
9	..	..	..	..	..	..	..	..	..	..	..	..	131	145	101	113	111	127	98	110	80	91	84	96	73	76	73	79	62	69	43	48	36	43	61	63	..	..
8	..	..	..	..	..	..	..	..	..	..	..	..	96	109	83	95	88	99	93	107	81	90	88	99	69	78	42	47	55	61	47	53	38	40	38	45	..	..
7	..	..	..	..	..	..	..	..	..	..	..	..	..	..	62	71	76	86	76	90	70	82	142	163	84	97	67	77	60	69	53	61	38	43	67	75	54	63
6	..	..	..	..	..	..	..	..	..	..	..	..	..	..	35	50	67	78	71	84	60	69	67	78	55	65	..	..	53	62	..	..	..	..	..	..	..	..
5	..	..	..	..	25	31	..	..	50	60	55	66	11	13	43	52	77	92	46	56	20	24	52	62	45	54	..	..	53	61	..	..	..	..	33	38	..	..
4	42	54	36	46	..	..	35	43	68	82	47	59	36	47	51	62	63	73	57	69	37	57	..	..	94	117	28	33	..	..	..	..	..	..	..	..	..	..
3	..	..	..	..	..	..	..	..	..	..	27	36	36	43	37	46	36	47	24	33	29	38	..	..	32	42	21	28	22	29	..	..	33	43	20	25	..	..

The values of c and c' given in the table vary a good deal even for flues of nearly similar dimensions, but particularly when those dimensions are extreme one way or the other. Such variation will be easily understood when it is explained that the figures are calculated from the actual pressures at which the boilers are insured, and that these pressures are not always the maximum pressures for which the flues are fit. Where therefore the dimensions of the flues are unusual, and the number of boilers subjected to calculation small, a few boilers working at pressures relatively very high or very low affect the average value of c and c' considerably.

The constants also decrease in a marked way, both with the lengths of the flues and with the diameters; the reason being that a very large number of the small boilers are worked at pressures between 30lb. and 50lb., although fitted for much more, and that the maximum pressure allowed on short flues is always less than that allowed on long ones, in proportion to the strength calculated by either of the formulæ.

In selecting the proper constants for the different lengths of flues we must therefore not be guided entirely by the table, but must make such a selection as a knowledge of the circumstances suggests.

For long flues the proper constant is easily determined, because most of the boilers with flues about 30ft. long, and from 32in. to 36in. diameter, are mill boilers and boilers used for trades in which the highest permissible pressures are habitually required. The mean of the numbers underlined in lines 28 and 30, and columns 32, 34, and 36, viz., 288, may therefore be taken as a fair index of the pressures at which long flues are usually worked, and for which long experience has proved them to be safe.

With regard to short furnaces, no evidence can be obtained from the table, but by considering the pressures at which the few unstiffened furnaces of small vertical boilers, and the many short unstiffened lengths between the flanges of Lancashire boiler flues are safely worked, the writer is confident that a constant of 100 may be safely used. Adopting, then, these constants for lengths of 30ft. and 3ft. 6in. respectively, it will be seen that they vary almost exactly in the ratio of the square roots of the lengths, and therefore that Fairbairn's formulæ may be thus modified—

$$p = \frac{K\sqrt{L} \times T^2}{L\,D} = \frac{K\,T^2}{\sqrt{L}\,D}$$

a form which, if not exactly correct, accords fairly well with the results of practical experience. The value of K is obtained by equating $K\sqrt{L}$ to c; thus, assigning to c the values 288 and 100, we get for the long flue, $K = 288 \div \sqrt{30} = 50{\cdot}5$; and for the short, $K = 100 \div \sqrt{3{\cdot}5} = 53$, a difference of only 5 per cent.

Adopting the lower number as convenient to remember, it may be said that the formula

$$\text{Working pressure} = \frac{50\,t^2}{D\sqrt{L}}$$ (t being taken in thirty-seconds of an inch)

gives a very near approximation to the safe working pressure. For fireboxes of about 5ft. diameter, such as are common on the donkey boilers of steamships, but not so often used on shore, the formula gives a working pressure rather in excess of what the company generally allows; but by making a slight correction it will embrace these also, without alteration of the constant. The writer therefore suggests the following formula as applicable to all cases likely to occur in practice:—

$$\text{Safe working pressure} = \frac{50\,t^2}{\sqrt{L}\,D} - \frac{D}{L}$$

t being taken in thirty-seconds of an inch (if t be taken in sixteenths the number 200 must be used instead of 50).

D the diameter in inches.

L the length in feet.

The determination of the constants 288 and 100, on which the formula depends, may seem to some to rest upon no surer foundation than mere opinion of what is safe; but this is not so. On the contrary, it is the direct result of actual working, extending over many years, made under practical conditions, and embracing the widest range. Nor are these constants the limiting values reached in working, for, as already explained, they are the mean values of a large number of constants, of which the majority are low rather than high, an insurance company always having on its books far more boilers working well within the limit of safety than just at that limit.

If, therefore, the maximum constants have proved to be safe, *a fortiori* so are the means. The cases in which the highest constants have been allowed, though relatively few, are not inconsiderable in absolute number, being the doubtful cases among more than 16,000 boilers insured by this company. Moreover, as these maximum constants have been fixed in accordance with the teaching and in the light of the experience of the company's managing director, who, when chief engineer of the Boiler Insurance and Steam Power Company, was called upon to settle the pressures in all doubtful cases among upwards of 50,000 boilers, it may be claimed that they have been based upon an experience of upwards of 66,000 boilers. In no case have these maximum constants proved to be unsafe, though the majority of boilers to which they have been applied are old ones which have worked for many years.

In the second place, it should be mentioned that the thickness or values assigned to T in the calculation of the constants in the table are the nominal original thickness of the plates as shown on the dimensioned sketches of the boilers, and are therefore greater than the actual thicknesses of those plates after years of service. If, then, these constants have given a safe working pressure when the plates were actually thinner than has been assumed, again, *a fortiori*, they must be sufficient when the actual thickness is taken. That they have been sufficient since the passing of the Boiler Explosions Act is proved by the reports of the Board of Trade surveyors. That they were sufficient before that time the writer here affirms. He therefore recommends the formula above given with perfect confidence, only remarking that it is to be taken as a guide, not as a law. In ordinary iron flues, lap riveted and nominally cylindrical, it may be applied unchanged; in other cases the pressure may be increased or reduced, according to the condition of the flues—to what extent must be left to the judgment and experience of the engineer. No rule can possibly be laid down.

Perhaps when the whole of the boilers of which the company has particulars have been gone over, some slight change in the constant may appear desirable, and the correction $\frac{D}{L}$ may be dispensed with, or put into a less unscientific form; meanwhile it is hoped the formula given may be of use.

CORRESPONDENCE.

We do not hold ourselves responsible for the opinions of our Correspondents.

PITCH OF PROPELLERS.

To the Editor of "The Practical Engineer."

SIR,—Allow me to thank "Orion" for pointing out what he rightly terms a slip on my part with respect to the distance G, as given in reply to "Port Glasgow." The omission is of some slight importance, but from the description of the principle involved, as given in that answer (previous to the omission in point)—that is, in the case cited, where a slip of paper of certain shape is wound round a cylinder of necessary diameter—it would be self-evident that the length of the base line a, c, in fig. 1, would require to be measured as a circumference, and therefore any portion of that base line we might take in our practical example would, of necessity, be a portion of that circumference, and should be measured accordingly. The omission arose from the want of being a little more explicit as to the meaning of the term "distance G," and is somewhat analogous to that in the case of toothed wheels, where it is usual to say that "the circumference of the pitch circle of a toothed wheel is equal to the product of the number of teeth and the pitch"—the manner in which the latter should be measured being left undefined, but self-evident. Again thanking "Orion" for his correction, I am, yours truly, OMICRON.

P.S.—In my answer to "Port Glasgow," the word diameter in the 15th line should read *dimensions*.

DEFECTIVE VALVE DESIGN.

To the Editor of "The Practical Engineer."

SIR,—Your correspondent, "Right Angle," who has evidently taken a very intelligent interest in the article which appeared under the above title in *The Practical Engineer* of July 27th, is quite right in assuming that many engines are working with valves similarly malformed, and even in condensing engines attempts are often made to improve the vacuum in the cylinder, which appears to go much worse in the middle of the exhaust stroke, owing to the valve cavity being too small, as illustrated in the above-named article.

The makers of the engines in question, many years ago, were in the habit of using almost any valve pattern which could be made to "come in" without much alteration, irrespective of how the distribution of the steam would be affected, this being considered a merely secondary matter, if indeed it were ever at that time considered at all. I have in consequence known many instances where diagrams taken from engines made by the same firm have shown a marked rise in the exhaust line, even in condensing engines; and in a number of cases immediate improvement in the effect of the vacuum in the cylinder (particularly in the middle of the stroke) has been made by simply chipping or "bevelling off" the inside corners of the exhaust cavity of the valves, and in this way temporarily enlarging the cavities until new valves of proper proportions could be made.

The diagrams taken with the reduced traverse, although the steam is cut off earlier, certainly do not show so much earlier a cut-off as might be expected with the difference in traverse, but this may probably be attributed to the valves not being in very first-class condition; as it will be seen from the diagrams, the cut-off is not very sharply defined, and the rounding of the steam line at this point appears to denote a certain amount of valve leakage. It is quite true, as "Right Angle" points out, that the back edge of the valve at each end passes over the exhaust port seven-sixteenths of an inch, letting steam from the valve box into the exhaust pipes between the cylinders, which will be a source of still further loss from the defective valve design. This will occur when the valve is steaming with full port opening at the opposite end, the high-pressure piston having then travelled some distance on its stroke, and the effect of this second admission of live steam on the exhaust side will be to still further augment the rise in the high-pressure compression line towards the middle of the stroke. It is not likely that this will much affect the low-pressure diagrams, however, the low-pressure valves at this point having shut off the connection with the low-pressure cylinder.

Your correspondent, "Valve Gear," will probably see that although the extreme opening of steam port is reduced by the alteration of valve traverse, the increase in the initial pressure shown after the alteration is what was to be expected, when he reflects that the effect of reducing the traverse of a slide valve and retaining the same amount of "lap" is practically the same, so far as point of cut-off and expansion are concerned, as adding more "lap" on the steam side and maintaining the same traverse. A perusal of "Right Angle's" letter, where the difference in point of cut-off for the two different conditions of working is given, will doubtless have convinced "Valve Gear" of this. The case is an interesting one, and as sufficient justice could not be done to it in one article, within the limits of space assigned, it may be added that it is intended to revert to the subject at an early date, when copies of the low-pressure diagrams will probably be given as desired by "Right Angle." This, it may be further stated, will be in connection with a series of articles on "Valve Design and Diagram Practice," illustrated with a number of diagrams taken in actual practice.—Yours, &c.,

The Writer of the Article.

IMPAIRED VACUUM.

To the Editor of "The Practical Engineer."

Sir,—Your correspondent, "Young Engineer," is wrong in saying I attributed the loss of pressure between his boiler and engine to the fact that the governor was doing its work satisfactorily. This I know to be a very common explanation of the loss of pressure, and I suggested that it *might* be so in his case, but pointed out how he might easily determine it for himself. He now gives some more information, and says his engine has double beat valves. These are in some places known as "Cornish valves," and are not a good type of valve for expansive working and sharp cut-off, or getting a close approximation between the boiler pressure and initial pressure in the cylinder, such as can be obtained with the best kind of cut-off valves—with the "Corliss valve," for example.

My remarks respecting the throttle valve may be applied with equal force to the double beat valves. Have they sufficient lift? Has "Young Engineer" tried the effect of giving them more lift, or can he arrange his cams so as to do so? I think it very probable that the obstruction referred to in my previous letter may be found here. I never knew as good a vacuum obtained in the cylinder with double beat valves as with ordinary slide valves. There is necessarily too much space to fill with double beat valves, and the valves cannot be placed sufficiently near their work to obtain a clear and sharp cut-off. They are, of course, in perfect equilibrium, easy to work and adjust, but this, I think, is about all that can be said for them, and they are not to be recommended for high grades of expansion. "Young Engineer" does not inform us whether he has succeeded in improving his vacuum at all or not, and I may just remark that whatever may be the real cause of the serious loss between the condenser and cylinder, he can easily bring about as great or even a greater loss by restricting the lift of his exhaust valve sufficiently. Perhaps this may suggest to him how he may also bring about the result he desires. If not, I would further suggest that he would send particulars of the lift of his valves, with copies of indicator diagrams. I am of course assuming that he is sure as to the correctness both of his pressure gauges and his indicator springs, and that he is not endeavouring to find a cause for a discrepancy which does not exist, which is sometimes done.—Yours truly,

Mechanical Engineer.

Shaft-sinking through Sand.—A new and ingenious scheme for sinking a shaft through sand, silt, and wet, slushy grounds, and excavating it like rock, has just been successfully tried in Belgium. Large iron tubes are sunk in the sand or mud about 3ft. apart, and in these tubes smaller tubes are inserted, through which circulates a cool solution of magnesium chloride. The sand is frozen for a distance of 3ft. around the tubes. It resembles rock, is hard and compact, and can be excavated in the same manner as rock.

QUERIES AND REPLIES.

Marine Engines.—Will some engineer kindly inform me the way sea-going engineers take lead, and accept information respecting journal brasses? What thickness or clearance is usually allowed for top and bottom ends How are thrust bearings with collar adjusted.—Ignorant.

Answer.—Lead can be got by turning the engine with the valve chest open. Clearance is usually about half an inch. The thrust block is adjusted with iron or steel wedges, which set the block farther astern to make up for wear.—X.

Horse Power.—Will you kindly inform me of the horse power of my engine: Cylinder 3in. bore, 7in. stroke, feed by ¾in. pipe from boiler 5ft. 6in. long, 20in. diameter.—Alec. Laurence.

Answer.—Your engine would be called about three-quarters of a horse power, but the power which it would actually develop would depend upon the speed at which it was run, and the pressure of steam used. It might be made to give out two indicated horse power.—Ed.

Working Drawings.—Many thanks to "J. R." for information regarding working drawings. I quite see how the arrangement is now, but has not "J. R." made a mistake in saying the transverse distance bars pass through the bottom holes of base plate; ought it not to be through supporting strap and columns only?—Constant Reader.

Navy Electrician.—Could you or any of your numerous readers give me any information as to the requirements of electricians in the Navy, and how one who has a good knowledge, both practical and theoretical, of electric lighting may become one?—T. H.

Drawing of a Pullman Car.—Could any reader inform me where I could get a working drawing of a Pullman car and a railway carriage?—E. P. S.

Cement for Brass.—Will you or some of your numerous readers kindly give me a recipe for or the name of the best manufactured cement for brass? I want to attach brass rings to the outside of a brass cylinder by means of cement.—Marine.

Repairs to Waterwheel.—Can any of your readers inform me how to put a segment on a waterwheel, and three pieces of the shrouds, and true the wheel? It is an iron wheel, with iron arms and cutters. Is there any book on this subject?—One in a Fix.

Starting Gear.—A sketch and description of "Brown's steam and hydraulic starting gear" would be appreciated by Shiny Boots.

Moment of Inertia and Radius of Gyration.—The meaning of these expressions, and an explanation of the uses of the formulæ, would be valued by Shiny Boots.

Cast-iron Gutters.—Can any reader tell me the technical name of the cast-iron gutters that connect the down pipe from the roof to the gutters along the pavement of a road?—H. L. Crate.

Portland Cement.—I should be glad if some reader would tell me the strength of Portland cement for beams, and also for fireproof floors. I should also be glad of a section of a fireproof floor capable of bearing a load of 3cwt. per foot the floor having a span of 20ft. clear.—H. L. Crate.

Hauling Drum.—Thanks to "N. A." for answer to my question. Will he kindly tell me what he means by difference between pinion and drum spur wheel, so that they may run smoothly? Does he mean the teeth on pinion to be thinner, or what?—A Subscriber.

Lift for Pump Clacks.—Will you oblige by giving the required lift for pump clacks or valves, and how to calculate the same in plain figures? Ex. 1.—For a 5in. ram pump, 2ft. 6in. stroke, running 30 revs. per min. Ex. 2.—For a 9½in. ram pump, 1ft. 9in. stroke, running 26 revs. per min.—Engine Attendant.

Pumping Water.—I have a 6¾in. Tangye pump pumping out of river 4in. suction pipe; distance between pump and river, 150 yards; rise, 12ft. If I put this pump on above a certain number of strokes per minute, say 30, the water piston falls half way into working barrel before reaching the water. At 30 strokes it works perfectly solid. Will someone kindly help me in this matter. I want to run 60 strokes per minute?—Tangye Pump.

Diameter of Fly-wheel.—Will some reader of your paper kindly inform me the best rule to calculate the diameter of a fly-wheel for an engine of a certain H.P., the solidity of its rim, also how to find power of an engine, say 60 H.P.—Zeta.

TO CORRESPONDENTS.

Longest Railway Run.—In answer to "Loco," the longest railway run in the world is, we believe, that from Dublin to Cork, on the Great Southern and Western Railway, in Ireland, the distance being 165½ miles; but as the train occupies 3 hours 47 minutes in performing the journey, it is not to be compared as a feat with the eight hours' performance of the London and North-Western and Great Northern Railways between London and Edinburgh.

Size of Engine.—The query addressed to us by "Stationary Engine" is rather absurd. Engines are made in every gradation of size from the small toy, which can be placed under a thimble, up to the giants which drive the Atlantic liners, so that it is impossible to say what is the smallest size for practical working.

R. R. Wilson.—You cannot do better than attend some good Science Classes in connection with the Science and Art Department, South Kensington. See answer to R. D.

R. D.—Your best course would be to become connected with some evening science classes, if there are any such in your town, and get some knowledge of mechanical drawing, &c. If not, then get employment in some town where such classes are held. Tate's "Elements of Mechanism" and "Exercises in Mechanics," by the same author, published by Longmans at about 1s. 6d. each, are very useful for beginners, and when you have increased your mathematical knowledge, you would find Goodeve's "Textbook on the Steam Engine," published by Crosby, Lockwood, & Co., a very useful book for giving you both a theoretical and practical knowledge. Any of these books may be obtained from the offices of *The Practical Engineer* by forwarding stamps for the amounts named.

MISCELLANEA.

Electric Lighting in Birmingham.—The Corporation Street Estate Company, Limited, which is building an important block of shops and offices in Corporation Street and Martineau Street, has decided to light the new buildings with electric light. There will be 20 shops and 64 offices in the block, which will be fitted with incandescent lamps, and the tower will be surmounted with a powerful arc light.

Railway Gauge.—The "Encyclopædia Britannica," ninth edition, thus accounts for the 4ft. 8½in. gauge: "The facts seem to be that the track of the original carts or trains, 5ft. wide outside the wheels, was taken as a standard for the gauge of rails, which was measured outside also. The width of the single rail at the top being originally 1¾in., the width of the two rails together is 3½in., which leaves 4ft. 8½in. for the inside measure or true gauge."

The Race to Edinburgh.—On the third day of the accelerated service of fast trains between London and Edinburgh, the ten o'clock express from Euston performed a remarkable feat. The engine No. 275, with six coaches, left Crewe at four minutes past one, and accomplished the journey to Preston, 52½ miles, in 50 minutes. Leaving Preston at 2-20, it drew up at Carlisle at 3-50, being 15 minutes before time, having run the distance from Preston over Shap Fells, 90 miles, in 90 minutes. This is claimed by engineers as beating every previous record.

Industrial Enterprise in Japan.—The progress of industrial enterprise in Japan was very marked in 1887. In Tokio Osaka, and Kioto no fewer than 111 large companies, industrial or commercial, were formed in the course of the year, with an aggregate capital of $21,500,000. At the close of December, 1887, there were no fewer than twenty-two spinning mills at work, representing 76,000 spindles and a yearly output of 1,320,000lb., while eight new factories had been projected.

Electric Locomotive.—Sir Edward Watkin, addressing the meeting of the shareholders of the Metropolitan Railway Company last week, said a locomotive engine was being constructed to be worked by electricity, and when it was completed it would be tried on the northern, or country, part of their railway. If it complied with all their conditions—and the experiments were to be at the cost of the Electric Traction Company—they would try and substitute it for the old-fashioned engine on the Underground Railway, and they would then have a locomotive which would make no smoke and give no trouble as to ventilation.

Burnishing Iron and Steel by Electricity.—The following method for burnishing iron and steel by means of the electric current was communicated by A. de Meritens at a recent meeting of the International Electric Society in Paris. The layer of oxide on the surface of the metal is obtained by placing the same as anode in a bath of common or distilled water. The sides of the vessel holding the liquid, or a piece of iron, copper, or carbon, are used as cathode. The temperature of the water is kept at 160° to 175° Fahr. The electromotive force must be just strong enough to decompose the water, as a current which is too strong gives a dusty layer which is not permanent. Under the action of the oxygen liberating at the anode, a layer of a black oxide (Fe_3O_4) forms on the metal. This layer can be easily polished, steel giving the best results, while on cast and rod iron a more dusty layer is obtained, though the use of distilled water makes the polish permanent.

Railway Dividends.—The report of the directors of the London and North-Western Railway Company for the half-year ending June 30th states that the net profit available for dividend admits of payments at the following rates: Four per cent per annum on the guaranteed, 4 per cent per annum on the preference, and 6 per cent per annum on the consolidated stocks. The report of the directors of the Lancashire and Yorkshire Railway Company states that the balance available for dividend on the ordinary stock is £327, 15, out of which amount the directors recommend the proprietors to declare a dividend at the rate of 3¾ per cent per annum, payable on August 16th, and to carry forward a balance of £13,421 to the next account. The report of the directors of the Great Northern Railway Company (Ireland) shows a revenue of £309,866, against £309,961. The balance of £92,712 is available for dividend on the ordinary stock, and the directors recommend a distribution at the rate of 5 per cent per annum, less income tax, payable on the 1st of September, leaving £7,503 to be carried forward.

Fast Railway Travelling.—There would appear to be some probability that the railway race to Edinburgh will not last long. At the meeting of the London and North-Western Company, on Tuesday, several shareholders complained of the undue competition and the excessive speed, but the chairman pointed out that they were not to blame for it. For a long time the East Coast companies had beaten them by an hour, though their route was only four miles shorter than the West Coast lines, and then, without giving them notice, they again increased their speed. The North-Western were bound to retain their share of the traffic, and to do this they increased the speed of their trains. At the present time Manchester is 21 miles nearer to London by the London and North-Western route than by the Manchester, Sheffield, and Lincolnshire and Great Northern. Yet the North-Western had not complained that the other companies performed the journey in the same time, though, as a matter of fact, they could traverse the distance in 3¾ hours, but they did not mean to do it. The general managers of the North-Western, the Great Northern, and the North-Eastern Company had a conference on the subject on Tuesday, the result of which is not yet known, but Sir Richard Moon expressed a hope that a friendly and amicable settlement of the present difficulty would be arrived at.

SELECTED PATENTS.

APPLICATIONS FOR LETTERS PATENT.

June 1st.

8002a Compressing Air into Reservoirs, L. A. Groth, London. (J. F. Monnot, France.)

August 3rd.

11226 Coupling and Uncoupling Railway Rolling Stock, H. Ridley and J. Lord, London.
11228 Metallic Packing, A. T. Allen, Sheffield.
11231 Motive Engines, C. Smith, jun.. and R. Williams, Liverpool.
11234 Steam Boilers, E. C. J. Devis, Glasgow.
11242 Gas Engines, T. B. Barker, Birmingham.
11243 Box Nailing Machines, D. Rylands and C. Emmet, Barnsley.
11246 Looms, J. F. Haggenmacher, London.
11249 Siphon Drain Pipes, W. Ross, jun.
11251 Weighing Machines, W. Snelgrove, Birmingham.
11258 Sorting and Sizing Corks, J. Pierpoint, London.
11259 Bobbins for Spinning, A. R. Donisthorpe, Middlesex.
11261 Smoke Escape, G. R. Tasker, London.
11266 Crushing Ore, &c., F. Clench and J. Coates, London.
11268 Condensing Apparatus, E. Theisen, London.
11270 Manufacture of Aluminium, J. B. Spencc, London.
11276 Carding Machines, J. Cheyne, London.
11280 Steam Engines and other Motors, H. H. Lake, London.

August 4th.

11285 Metallic Packing, J. Patten, New York, United States.
11286 Life-saving Device, T. C. Chappell and E. D. Moore, Manchester. [Complete Specification.]
11301 Signalling at Sea, W. W. Horn, Middlesex. (D. Ruggles, United States.)—[Complete Specification.]
11303 Motive-power Engines, J. W. Melling, Manchester.
11304 Archimedian Screw Steam Jacketed for Drying Hops, L. J. Meakin, Burton-on-Trent.
11307 Stationary Compound Steam Engines, W. Hargreaves and W. Inglis, Glasgow.
11310 Loom Shuttle Tips, D. Irvin, Manchester.
11311 Steam Winches, C. Elliott, Sunderland.
11315 Petroleum Compressed-air Engines, C. Wells, London.
11316 Cutting Tools of Lathes, &c., P. M. Justice, Middlesex.
11317 Cleaning Feed-water Passages, J. Ellis, London.
11322 Expanding Reeds for Looms, W. Terry and F. Rawnsley, Bradford.
11325 Pulverising Apparatus, A. G. Wass, London.
11330 Printing Machines, A. Fayol, London.
11331 Hollow Screw for Oiling, E. Partridge, London.
11337 Telephone Line Circuits, L. Kelner, London. [Complete Specification]

August 7th.

11343 Elastic Web Picking Machines, A. Bradsworth, Leicester.
11345 Spinning and Doubling Textile Materials, S. W. Wilkinson and F. Wilkinson, Manchester.
11349 Screw Gill Boxes, D. Reed, Manchester.
11356 Heat Engines, A. Fehlen, London.
11359 Air-compressing Pumps, E. O. Fasoldt and E. W. Smith, London.
11368 Moulding Machines, F. G. Leeder, Glasgow.
11370 Multiple Cylinder Motors, S. Fox, London.
11375 Steam and Compressed-air Engines, A. Gough, London.
11376 Siphon Recorder Telegraph Instruments, G. Draper and W. H. Ash, London.
11382 Packing for Steam, Water, or Air Joints, T. B. Turner and W. C. Leach, London.
11384 Ring-spinning and Thread Machines, F. M. Franke, Liverpool.
11386 Wire Rods, J. T. King, Liverpool.
11389 Central Station Heating Systems, C. A. Day, London. (The National Heating Co., United States.)—[Complete Specification.]
11394 Straightening Railway Rails, L. Richards, London.
11404 Spindles, J. R. Milson, London.—[Complete Specification.]
11405 Finishing Cloth, D. Gessner, London.—[Complete Specification.]
11407 Staking Leather, J. F. Ingraham, Middlesex.—[Complete Specification.]
11408 Screw Propulsion, G. A. Lewis, London.
11410 Screw Propellers, A. D. Hall and G. B. Sloan, London.—[Complete Specification.]
11411 Dynamo-electric Machines, A. W. Meston, London.—[Complete Specification.]
11412 Winding Thread, G. Scelles, London.
11413 Printing Machines, W. Millard, London.

August 8th.

11422 Railway Fog Signal, A. Campbell, jun., and W. R. Lawson, London.
11433 Warming and Ventilating Buildings, J. Jackson, Newcastle.
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EDITORIAL NOTICES.

All communications for the Editor of this Journal should be addressed to 6, Victoria Station Approach, Manchester.

Communications intended for insertion in the current week's issue should reach us not later than Tuesday Evening.

We cannot undertake to return rejected manuscripts or drawings unless accompanied by a stamped and directed envelope.

Contributors are requested to write on one side only of the paper. Sketches should be sent on separate sheets.

TO ADVERTISERS.

Advertisements intended for insertion in the current issue should reach us on Wednesday morning at the latest.

THE
PRACTICAL ENGINEER.
AUGUST 24th, 1888.

NAVAL INEFFICIENCY.

It is seldom that any attempt at manœuvring our warships is made but some unpleasant defect is brought prominently forward. The difference between the nominal and actual speeds now supplies a cause for complaint. When we find that vessels like the Belleisle and Devastation, of which the speeds are officially quoted at twelve and fourteen knots respectively, unable to sustain a speed over nine and a half knots in smooth water, it is evident there is something seriously wrong; yet this is what we learn from correspondents accompanying the manœuvring squadrons. Some short time since it was found that certain of our "protected" cruisers could not carry their full equipment without so deep an immersion that their protecting belts were entirely below the water-line, thus leaving them unprotected just where impermeability is most important.

It is of the greatest consequence to ascertain how such mistakes arise, and how in future they are to be avoided. It is nothing to the point that ex-constructors to the navy criticise and quibble over the shortcomings of their successors, from generation to generation. Whatever particular views may be held by these officials as to what we require, one thing is certain, and that is, that whatever is decided upon should be properly carried out. If the constructors are instructed to design a ship to make a certain speed, we ought not to find that after it is built it will not sustain the speed decided upon; and if a ship is ordered to be armour-belted two or three feet above the water-line, the top of the belt should not be found six inches below that level when the vessel is fully equipped.

When we come to the actual construction of vessels of war, we are supposed to have passed from the vague realms of controversial opinion into a world of hard mechanical facts, where no doubt can arise as to the results that will accrue from any definite course of action. The displacement of a vessel to carry a given load is easily calculable; it is not a matter of guesswork or speculation; neither is the weight of the ship itself, or the effective duty of the engines by which it is designed to propel it.

We do not of course pretend to say that in these calculations we can work to the last decimal in our quantities, but they may certainly be made to approximate so closely to the practical result—in the matter of displacement—that only a slight margin for adjustment of ballast will be required. The ships are laid down on well-defined mathematical lines, from which the bulk enclosed by the surfaces which they bound may readily be calculated, and therefore the displacement arrived at without difficulty.

In regard to engine power and boiler capacity there is a greater freedom of action open to the constructor, for here the limit is only in one direction. In displacement, the water-line is a fixed position, but the power required will only have a lower limit; it must not be less than sufficient to propel the vessel at some definite speed; and it is therefore open to the constructor to allow such margin of power additional as his experience shows to be necessary for the class of engines adopted.

The most salient fact which confronts us in connection with our present subject is, that to find errors and fiascos such as those alluded to we must turn to our navy, where there is no stint of money, and where, therefore, there should be no lack of ability. The private steamship companies have no difficulty in getting their vessels built and engined according to their specifications, and it is not only on their trial trips they give satisfaction, but in their continuous running, as has recently been abundantly proved by the various liners starting from English ports to America and other parts of the world; and it seems incomprehensible, if the Cunard and other companies can find naval architects and marine engineers to execute their orders satisfactorily, that the Government, with practically unlimited resources, cannot do likewise. It is not to be attributed to the classes of ships being different, for that is merely a matter of degree and not of principle, though even had it been it would furnish no excuse, in view of the wide and sudden departures that have been made in the mercantile marine. Take as an instance the Great Eastern; although commercially a failure, yet as a steamship she was a splendid success from a technical point of view, and remained so up to the time she was dismantled, although all the time she was being built there were plenty of people to be found who prophesied nothing but evil for her, so great was the departure from the common practice of shipbuilding at that time. In the navy it seems that a very slight deviation from the beaten track may lead to most serious and disastrous misconceptions.

Discrepancies in the matter of displacement of the vessels may be set down as simple and inexcusable blunders on the part of the designer, and so dismissed; but the speed question will bear a little more discussion. Its consideration involves many points of interest, for we have to take up the case of a vessel which gives satisfaction on its trial trip, but subsequently in general working fails to maintain the standard of efficiency laid down for it.

The fault that militates against the maintenance of speed under continuous steaming for any length of time may lie in the engines or in the boiler, but wherever it is, it certainly should be discovered during the preliminary trials. If the fault is in the boiler, it may be due to insufficient heating surface or too little grate surface, but assuming these to be properly apportioned, it may come from the choking of the firegrate by clinkers. This may be avoided by using some form of oscillating or vibrating firebars, which, by their constant movement, will break up the clinker as it forms, so that it will fall through the firebars into the ashpit, and leave the grate clear. Raking the clinkers up by hand, especially on a thick fire, will not do much good, as in their passage through the fire they may fuse together, and so form larger clinkers, especially where the temperature of combustion is high, as in the case of forced draught.

Assuming the engines to be made of a power commensurate with the work required of them, they may fail to yield that power by reason of bad vacuum, and this will, of course, be due to some fault in the construction of the condenser or its pumps; hence it will not occur when the engines are properly designed, and where it does exist there is no remedy for it but replacing the defective parts by others of suitable dimensions. The tendency of bearings to become heated will also limit the speed at which the engines may be driven continuously, but this will not be found if the lengths of the bearings are correctly proportioned to the pressures to which they are subject.

Another difficulty by which some of our largest ships are beset is that of steering; they are not unfrequently in collision, or otherwise in some position in which they should not have been, and this we must conclude to be due to some defect in the steering apparatus or in the method of using it. It follows, as a matter of course, that the heavier a vessel is the greater will be the difficulty of handling it, and there is, therefore, all the greater reason why special attention should be devoted to the steering arrangements; and if those now in use are not suitable to the heavier classes of ships, others should be devised better adapted to meet the purpose, and less liable to break down under unusual strains.

The action of the rudder does not seem to be so thoroughly mastered as is desirable, for in many instances the results are disappointing to the designers, without the reason being immediately evident. No doubt if more attention were devoted to this matter information of a valuable character would be obtained, and no time can be considered ill-spent that would tend to the establishment of data by means of which the conditions under which ships, however heavy, could be handled with certainty might be determined.

The complaints about our navy have been so general and so continuous, that perhaps they do not command the attention to which they are entitled. Some complaints doubtless have their origin in interested motives; but the defects we have referred to in the foregoing remarks are of a purely mechanical character, and such as would not occur if proper attention were given by competent designers to the work of building and engineering our warships.

THE PHONOGRAPH.

The expectation that Mr. Edison would still further improve the effectiveness of the phonograph, and render it capable of wider application by making it into a loud-speaking instrument, so as to be capable of imparting its message to several hearers at once without the intervention of tubes extending from the instrument to the ear, has been abundantly fulfilled. Colonel Gouraud, who, it will be remembered, was the gentleman to whom Mr. Edison sent his first improved instrument, received a party of scientific visitors the other day in order to exhibit to them the capabilities of a second instrument which he had just received from Mr. Edison. The instrument is furnished with a sort of speaking-trumpet, and the sounds are distinctly audible to a large group of persons. Accompanying the instrument were a number of cylinders which Mr. Edison had forwarded from America, and which are said to have yielded up their record of sound with marvellous fidelity. One cylinder had been impressed with the sounds of Mr. Edison's workshop; another addressed the company in Mr. Edison's name; while others yielded forth various operatic airs. There can be little doubt that the instrument is capable of a number of practical applications of great utility, and before long we may expect the phonograph to be as familiar an adjunct to a merchant's office as the telephone. Colonel Gouraud states that it has become his custom to dictate his letters to his phonograph at his leisure, and an amanuensis sets the instrument in motion and writes from its repetition. The presence of a shorthand writer is thus dispensed with, while the recording cylinder remains as an enduring witness of the words spoken, and a test of the accuracy of the copyist.

TRADES UNIONS.

The formal report of the House of Lords Committee appointed to inquire into the sweating system establishes pretty clearly what careful observers have all along contended, viz., that organisation amongst workpeople is to be encouraged rather than deprecated, as capable, when not abused, of conferring mutual benefits upon master and man, while the disappearance of the apprenticeship system is to be regretted on several grounds. Speaking of the practice of "sweating," the committee state that it is erroneous to suppose that the system affects all grades of industries alike. Indeed, the evidence given clearly points to the conclusion that the evil effects of the system are mainly confined to the lower branches of trade, where low-class labour is employed and *little or no organisation prevails.* It is in this class of work and among this class of people that we find men and women working from six or seven o'clock in the morning until 11 or 12 o'clock at night for "starvation wages," with "no hope for the future and no pleasure in the past;" while to the enormous supply of untrained and unskilled labour is traced the increasing production of inferior goods which are necessary to satisfy the public craving for cheapness, and which apparently meet with public approval, notwithstanding the fact that they are produced in "sweaters' dens" and by "sweaters' victims." Referring to the indirect evils of the sweating system, the committee regard the gradual decadence of the old-fashioned apprentice system as most important, and state that both masters and men have testified during the inquiry to the want of technical or secondary education; and also state that the increasing use of machinery and the minute divisions into which work of all kinds is now divided render untrained and unskilled boys able to perform the work formerly done by trained and skilled men. Nowadays few working-men or women know a trade in all its branches. Their object is rather to know a subdivision perfectly, with a view to becoming the foreman or forewoman of that division. This end is no doubt legitimate enough, but when trade is bad, and work is scarce, what, asks the committee, is to become of men and women who only know some particular subdivision of their trade? Too often this want of general knowledge compels them to join the ranks of the unemployed, while the difficulty of getting men who know their business, even in times when trade is good, appears to be great.

MATERIALS OF ENGINEERING.—IV.

Wrought Iron.

Wrought iron, also termed malleable and bar iron, is a tenacious material, showing a fibrous silky fracture when broken by gradually increasing stresses, but granular and crystalline when nicked and fractured by a sharp blow. It is highly malleable, ductile, soft, has a high melting point—roughly about 3,000° F.—and can be welded at a white heat. Its qualities are affected very sensibly by the presence of such foreign matters as carbon, sulphur, silicon, phosphorus, and manganese. Thus, sulphur in so small an amount as ·03 per cent is sufficient to induce red-shortness—that is, to render the metal brittle and unforgeable at a red heat; while ·75 per cent of phosphorus renders the metal cold-short—that is, it cannot be worked cold without cracking at the edges. Small percentages of antimony render metal both red and cold short; ·35 per cent of silicon suffices to make iron cold short and weak; but fortunately this is an element which is easily oxidised. Carbon should be present only as a mere trace, or less than ·1 per cent, though its proportion is often rather higher. The more free the iron is from the other ingredients named, the more carbon can it contain without becoming steely in character.

If we study in outline the methods by which the rigid, brittle, highly-carbonised cast iron is converted into the tenacious, ductile, malleable metal, low in carbon, we shall be better able to understand the reasons of the variations in the qualities of the different irons of commerce.

There are two methods employed for the production of malleable iron—the direct and the indirect. In the first the iron is made at one operation from the ores; in the second it is prepared from iron which has been already smelted and cast into pigs. The first has but slight commercial importance. By the second the bulk of the iron of commerce is manufactured. Since it is impossible to enter into a lengthy detail of the various methods of manufacture in use, I shall confine my remarks entirely to that particular branch of the indirect methods by which nearly all commercial iron is manufactured—that known as *puddling.*

In the older method, known as *dry puddling,* the processes and operations involved have undergone little change; but the newer process of *wet puddling* or *pig boiling* has very largely supplanted this.

In the dry puddling process only white or refined iron, in which all the carbon present is in the combined condition, and from which a large proportion of the silicon, sulphur, phosphorus, and manganese have been oxidised out, can be used. This process, therefore, involves a preliminary *refining,* which is effected as follows: The grey pig is melted on the hearth of a rectangular furnace in contact with coke or with charcoal, and in company with highly-oxidising agents, such as basic slags, cinder, and hammer scale; and an oxidising blast of air is directed upon it from rows of tuyeres, about five or six in number, inclined diagonally downwards towards the hearth. The metal is thus decarbonised, carbonic oxide being released as the various impurities are partly oxidised out. The resulting product is a hard, white, brittle metal, suitable for puddling.

Dry puddling is performed on the hearth of a reverberatory furnace, so that contact does not occur between the fuel and the metal. The bottom of the furnace is covered with a lining of oxide of iron. The charge of refined iron is placed around the sides of the furnace hearth, and the heat raised until it becomes partially fused, or "pasty;" at which stage the furnace damper is lowered, and the metal is "rabbled" over the hearth in order to mix it thoroughly with the oxide of iron, and with hammer scale, which is added to the charge. The impurities still remaining in the iron after the preliminary refining process are thus oxidised by these basic materials, and by the oxygen of the air which plays over it, with the evolution of carbonic oxide. As the iron is thus purified, it becomes also more pasty, until finally the mass "comes to nature," and is ready for "balling up" or working into lumps ready to be passed under the hammer or squeezer.

In the process of wet puddling or pig boiling it is not necessary that the metal should be refined, but grey pig iron, or a mixture of grey with white, is commonly used. In wet puddling the metal is mainly purified by immersion in a bath of molten oxides, instead of, as in the dry process, chiefly by the oxidising influence of the atmosphere.

In wet puddling, the bed of the reverberatory furnace is lined to a depth of a few inches with broken slags, with the tap cinder from previous heats, with hammer scale and old hearth bottoms broken up, and all fused together. Over these is placed a fettling of a soft red hematite known as "puddler's mine," consisting of nearly pure oxide of iron. The sides of the hearth as well as the bottom are fettled with roasted "tap cinder," or "bulldog," and with puddler's mine—all substances rich in oxygen. The fettling varies, however, in different districts.

The process of wet puddling embraces certain distinctly defined stages. In the melting down stage the graphitic carbon present is converted into combined carbon, and the silicon is partly oxidised. In the second stage the furnace damper is lowered, and the puddler draws the metal from around the sides and mixes it with that in the centre of the hearth. Then, at the third, or "boiling stage," the damper is raised, and a violent ebullition of the metal goes on for twenty or twenty-five minutes, during which time the carbon is being oxidised to carbonic oxide; the sulphur, phosphorus, and manganese being rapidly oxidised also. The "boil" is assisted by the puddler, who "rabbles" the metal constantly in order to expose fresh surfaces to the action of the fluxes and of the atmosphere. As the oxidising action draws to a close the bubbling ceases, and the metal "drops," or lies quietly, on the hearth. While in this pasty condition it is still worked about by the puddler for a few minutes. Finally, it is "balled," or broken up into balls of a convenient size, from 60lb. to 90lb. in weight, which are rolled to the fire-bridge to receive a final heat previous to being taken to the hammer or squeezer.

In brief, then, the puddling process transforms the crude cast iron, containing perhaps 93 or 94 per cent of metal, into the malleable product, containing about 99½ per cent of metallic iron.

The balls of metal, which are rolled to the mouth of the furnace, are withdrawn with the tongs through the working door, and placed on a bogey in readiness for the operation of *shingling* Though the metal in these balls consists of almost chemically pure iron, yet large quantities of cinder and slag are mechanically intermixed therewith, making them very *spongy* and unsuitable for any manufacturing purposes. Hence the reason for the process of shingling, which consists either of squeezing or of hammering the sponge in order to effect the expulsion of the cinder and slag which are intermixed with the metal.

There are numerous squeezers employed, both reciprocating and rotary in action, and also various kinds of hammers. The best modern practice is in favour of shingling by means of the steam hammer, the expulsion of the cinder and the consolidation of the metal being more effectual under this type of hammer than by the other methods.

The *shingled bloom* of malleable iron, having the bulk of its slag and cinder thus squeezed out, is passed while yet at a white heat into the first series of rolls, known as *puddling rolls,* or the forge train. These rolls are grooved out in descending series from left to right, the series to the left being termed the "roughing," that to the right the "finishing" rolls. The grooves are roughened to take better hold of the blooms. The iron being passed and repassed through this diminishing series, comes out as *puddled bar,* or *No. 1 iron,* and this is crude bar iron, not yet fit for smiths' use.

To produce *merchant iron,* the No. 1 bars are cut up or "cropped," made into *piles,* brought to a welding heat in the reheating furnace, in which, according to its type, solid or gaseous fuel may be used, and passed through the *mill rolls.* The details of the processes and appliances employed are too elaborate for treatment here. It is only with the results that we are intimately concerned.

The object of the *piling* is to obtain great strength, ductility, and homogeneity. The No. 1 bars, having been cropped, are laid parallel with one another, if for bar iron, or crossing one another if for plates, their ends being made to break joint. For plates, the top and bottom of the pile is made of single slabs, with no end joints. The whole, being bound together, is brought to a welding heat in the reheating furnace, and either consolidated under the hammer, and then passed through the merchant rolls, or is passed through the rolls direct. The size of the pile and the details of arrangement of the sections depends on the character of the bars and plates required.

The product of this process is No. 2, or *merchant iron.* This is the commonest used. The superior classes are prepared by a repetition of the process of cropping, piling, and reheating and rolling. "Best," or No. 3, "best best," and "treble best" irons, are produced from the previous grades by the repetition of these processes, each repetition resulting in an increase of homogeneity, ductility, and general good quality; and with a corresponding increase in cost, due to the labour, fuel, and machinery engaged thereon.

We are now in a position to study the qualities, behaviour, and uses of the malleable irons of commerce. J. H.

(To be continued.)

BOILER EXPLOSIONS.

Several reports of explosions investigated by the Board of Trade under the provisions of the Boiler Explosions Act have recently been issued.

Report No. 268 refers to an explosion which occurred on the 28th of November last at Castle Foundry, Caerphilly. The boiler, which was of the ordinary vertical type, and measured 4ft. in diameter by 7ft. in height over all, gave way in the external shell, which was torn from top to bottom, and peeled away from the crown plate and firebox. The shell plates measured originally $\frac{3}{8}$in. in thickness, but the report states that where the rent occurred the plate was reduced by external corrosion until in some places it was as thin as a sixpence, and in its wasted condition it is a matter of astonishment that the boiler held out so long. The owner stated the working pressure varied from 35lb. to 45lb. per square inch, but the Board of Trade surveyor reports that on examining the lever and weight of the safety valve he found the pressure could be increased to 90lb.

From the evidence brought out in the report, the boiler appears to have been very much neglected, and to have received but scant attention. It is perhaps needless to say that the boiler was not under the care of any boiler inspector or insurance company. The owner stated he examined it himself, and what his inspection was worth may be inferred from his statement that he examined it three weeks before the explosion, and also *tested it with steam pressure* to 60lb. on the square inch.

Report No. 267 deals with an explosion which occurred at Rainham Ferry, Essex, on March 20th. In this case the explosion was attended with fatal consequences, a young man who happened to be standing near being scalded and blown overboard into the river.

The boiler formed part of the outfit of a steam crane which stood on a pier, and was used for loading and unloading vessels. As in the last case, it was of the ordinary vertical type, measuring about 8ft. in height by 2ft. 6in. in diameter in the shell, and 2ft. 1½in. in the firebox, which was 4ft. 6in. high. The boiler was fitted with a glass water gauge, as well as with a dial pressure gauge, and also a safety valve loaded with a lever and spring balance, and said to have been usually set at 70lb. per square inch.

It was in the internal firebox that the boiler gave way, the side immediately adjacent to the firedoor being bulged in and rent open, forming a large opening, through which the scalding contents of the boiler escaped. The cause of the explosion was the wasting of the plates by corrosion, the original thickness of the firebox being reduced from $\frac{5}{16}$in. until at the collapsed part it averaged little more than $\frac{1}{8}$in. The boiler had, in fact, been slowly reduced in strength until it became at last too weak to withstand the ordinary working pressure.

As in the last case, the boiler was not enrolled with any insurance company, and the owners appeared to have entrusted the responsibility for this important duty, as well as that of determining the working pressure, to the engine-driver, who, as subsequent events proved, was quite unfit to discharge it.

METHOD OF CONSTRUCTING GEOLOGICAL STRATA MAPS.*

The map exhibited, as an example of my method of constructing geological strata maps, is essentially an educational appliance. The method, however, is available for the production of maps of comparatively small areas, which, I am confident, will be found of great practical value to mining engineers. Before stating how the method may be so applied, I will briefly describe the map exhibited, as the easiest way of making my meaning clear.

Almost any region might be taken. This map represents the eastern half of the United States; and the geology is that of the map issued by the Geological Survey, and revised and extended subsequently by Professor Hitchcock for your institute. I use ten cards, of the colours used in the geological map, each having the geography of the area printed upon it; and I superimpose these in the order in which the colours occur in the index to the map. I next cut away a portion of each card, excepting the the lowest, leaving only so much of each as represents the exposure of the formation of that colour plus all those which overlie it. When that is done, the whole, looked at from a distance, appears to be an ordinary geological map. Looked at more closely, however, the formations are seen to overlie one another, as in nature. The cards are covered with glass in a frame, which, hinged at the bottom edge, can be let down. The cards are then found to be all hinged in the same manner, and they, too, may be lowered, one after the other.

I am told by teachers of geology of great experience and the highest reputation that by this appliance they will be assisted in imparting to students the first facts and principles of geological science. Having let down the whole series of cards, until that representing the Archæan is seen underlying all the rest, the teacher will gradually rebuild it. The Cambrian will thus be *laid down* upon the Archæan before the eyes of the class, the Silurian upon that, then the Devonian, Carboniferous, Cretaceous, and so on. The teacher will explain that the superposition of the cards corresponds with that of the strata in nature; that the cutting away of portions of the cards corresponds to the work of erosion or denudation in nature; and that the steps formed by the thickness of the cards correspond to the encarpments of nature. He will show how the underlying cards crop out from beneath those by which they are overlaid, corresponding to natural outcrops. He will tilt the map, and illustrate dip and strike in nature. He may bend the cards so as to produce a synclinal trough or an anticlinal ridge. Inliers are beautifully exhibited where holes are made in higher cards to show lower ones. Outliers have to be produced by attaching a portion of a higher card, in place, to that underlying it. Conformability in stratification is also illustrated in the map.

In the application of this method to the requirements of the mining engineer, the area to be represented should be small, since the scale needs to be large. The layers of the map may then correspond to single formations instead of systems, as in the map exhibited, or they may correspond merely to beds, all belonging to the same formation. Nor need they be all of the same thickness throughout and spread out horizontally. Instead of cardboard, *papier-maché* may be used, shaped and made of variable thickness, to correspond with the several beds to be represented. On the successive layers of such a map, notes may be made of ascertained thickness, mineral characters, or underground workings, as the data are obtained.

So much for the strata map. Arising out of it I offer two suggestions:

1. Instead of corresponding to natural beds of distinct geological age, the cards may correspond to units of vertical measurement (say 10ft. or 100ft. each), still using colours, but graduated. On these such records as already suggested may be made from time to time.

2. This method is available for contour maps, each card representing a certain unit of elevation (as 10ft. or 100ft.). Starting, as in any contour map, from a given datum line or base, superimpose so many of the cards as may be necessary, and so shaped as to produce the contour effect required. Various colours, graduated or otherwise, may be used. In many cases a series of browns, using the darkest at bottom and lightest at top, would be advantageous, producing a perspective effect.

A High Railway.—The highest railway in the United States is the Denver and Rio Grande, the Marshall Pass on which is 10,852ft. above sea level.

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* Paper by J. T. B. Ives, F.G.S., Proc. American Institute of Mining Engineers.

THE FIRST CENTURY OF THE MARINE ENGINE.—II.

(Continued from page 389.)

For a record of early British steamers reference must be made to special historical treatises and papers,[*] our time only allowing us to notice a few of the chief of them. Among the shipbuilders the names of Wood, Steel, Scott, Denny, and Caird, and among the engineers those of David and Robert Napier, all of the Clyde, stand pre-eminent. Of the first of these Mr. Robert Duncan has remarked that "he was the father of all that is best in the style of our ships, and truest in the practical application of science in the shipbuilding of Great Britain;" while of David Napier, Mr. Scott Russell was of opinion that from the year 1818 until about 1830 he effected more for the improvement of steam navigation than any other man. He established deep-sea communication by steam vessels and post-office steam packets, first in 1818 between Glasgow and Belfast, by the Rob Roy, a vessel of 90 tons burden and 30 H.P., built by William Denny, of Dumbarton, which, after plying for two winters between the above-mentioned ports with perfect regularity and success, was used as a packet between Dover and Calais. About the same time he established a line of steamers between Liverpool, Greenock, and Glasgow. The Robert Bruce, of 150 tons, built by Messrs. Wood, the Superb, of 240 tons, and the Eclipse, of 140 tons, were all engined by David Napier, and their good proportions and construction did much to establish steam navigation on a firm basis and render it an object of national importance, and it from this time underwent great and rapid improvement. The construction of the James Watt in 1822 marked a decided step in advance. It was of 448 tons measurement, and was built by the Messrs. Wood, and in form, strength of construction, and speed, was much before every vessel of her day, having a speed of ten miles an hour. Her two engines of 50 H.P. were by Boulton and Watt, and were geared between the crank and the paddle shafts. From the time of the construction of the James Watt a gradual increase in the size and improvement in the design of the ships and engines took place, until what was called at the time the Leviathan class was reached.

As early as 1819, an American vessel, the Savannah, had crossed to Britain, partly sailing and partly steaming, while in 1833 the Royal William crossed from Quebec; but it was not till 1838 that Transatlantic navigation was established on such a basis as to prove that it would be commercially successful, as was done by the voyages of the Sirius and the Great Western. The Sirius was built by Messrs. Menzies, of Leith, in 1837, and her engines, which were of the side-lever type, were constructed by Wingate and Co., Glasgow, her tonnage being about 700 tons, and her horse power 250. The Great Western was the first steamship specially constructed for the Atlantic trade. She was built at Bristol by Mr. Paterson, and her dimensions were 212ft. in length between the perpendiculars, 35ft. 4in. breadth of beam, and 23ft. 2in. depth of hold; registering 1,340 tons, builders' measurement. Her engines, which were side-lever and 440 H.P., were constructed by Maudsley, Sons, and Field, of London, having cylinders 73½in. in diameter and 7ft. stroke, making twelve to fifteen revolutions per minute. The Sirius and the Great Western arrived in New York on the same day, April 23, 1838, the latter having performed the voyage in four days less than the former.

The practicability of Transatlantic steam navigation being thus established, many large steamships, both for commerce and war, were built in rapid succession, and well-known lines established. Among these need only be named the Cunard, the Collins, the Inman, the West-Indian Mail Steam Packet, the Pacific Mail Steam Navigation, and the Peninsular and Oriental Companies, all of which furnished many excellent examples both of ships and engines.

For the first twenty years after the establishment of ocean navigation the side-lever engine was employed almost entirely in the larger mail packet companies, and was essentially Watt's engine, modified in some details. The Americans used, and to a large extent still use the ordinary beam engine, for paddle steamers, but in Britain, in order to economise space and keep the centre of gravity of the engines low, they were inverted, and thus became what were called side-lever engines. Some of them were magnificent specimens of architecture, but engines of this type were by no means self-contained, the keelsons and framing of the vessels being largely relied upon for resisting the stresses arising from the action of the engines, and of course under such conditions a low pressure of steam and uniformity of motion were matters essential to their safe working. The pressure of steam was generally from 3lb. to 5lb., and seldom exceeded 10lb. on the square inch above the atmosphere, while the space occupied in the hull by the engines and boilers was nearly one-third of the ship's length. No trustworthy figures can be found to show the consumption of coal, but for the period mentioned it was seldom less than 7lb. per I.H.P. per hour. In a few cases horizontal engines were placed between the paddle wheels, but these were objectionable on account of the weight they caused to be placed on the deck. To obviate this difficulty the steeple engine was designed by David Napier, and continued to be used for many years, especially by river steamers. It is now, however, seldom made, the direct-acting diagonal or the oscillating engine (which was first designed by Penn, in 1837) being generally employed for paddle steamers.

When the screw propeller was introduced, chiefly through the exertions of Mr. F. P. Smith and Bennet Woodcroft in this country and Captain Ericsson in America, the same kind of engine was used for driving it as was employed for paddle vessels, the connection between the crank and the propeller shafts being effected by means of gearing. The first British steamer of any size fitted with a screw propeller was the Archimedes, 237 tons, and built on the Thames in 1839. It was tested under Admiralty supervision, between Dover and Calais, with the fastest paddle-wheel mail packets on the station, and so satisfactory were the results that the Admiralty felt justified in introducing the screw propeller into the Royal Navy, and they led to the construction of the Rattler, which was launched from Sheerness Dockyard in April, 1843. The Rattler proving satisfactory, several other screw vessels were built for the navy.

In the merchant service, also, the screw propeller made slow progress. The Great Britian, built in 1843, was the largest vessel of that day, and was remarkable not only for her size, but also because she was built of iron and was propelled by a screw instead of paddles. She was 322ft. over all in length, 48·2ft. in breadth, and 31·5ft. in depth, with a gross tonnage of 3,278. She was built at Bristol from the designs of Brunel, her engines were made by J. Penn and Sons, Greenwich, her boilers by Fawcett, Preston, and Co., Liverpool, and her engines were secured to the propeller shaft. The Great Britian made her first trip across to New York in fifteen days, and afterwards for many years was well known on the Australian trade. As screw propulsion became more common, gearing was gradually dispensed with, and the direct-acting inverted or horizontal engines were used. These may be looked upon as the normal type of engines for the larger vessels employed in the merchant service and the navy respectively.[*]

For a considerable time after the establishment of ocean steamship trade little attention was paid to the direct economy of fuel, although various causes, such as the improved form of the hulls, the use of iron in their construction, and the introduction of the screw propeller, led to a greater tonnage being propelled with the same amount of coal. There seemed to be a very general belief that high-pressure steam was not only unnecessary, but was positively a disadvantage and a danger. Gradually, however, this opinion changed as the necessity arose for extending trade to foreign countries where coal could not be readily obtained, and the pressure of the steam was gradually increased, although in many cases this seems to have been brought about in consequence of greater confidence in the materials of construction than from a distinct knowledge of the principles involved. Among those who led the way in the design and construction of engines of a more economical type the names of John Elder, Charles Randolph, and John M. Rowan deserve to be specially mentioned among Clyde engineers.

Telephonic Induction.—With the introduction of the telephone the interception of telegraphic signals has been much simplified, as by erecting a wire parallel to that through which the signals are being transmitted, and connecting with a telephone, each signal sent through the primary wire will be distinctly heard in the telephone by induction. In order to prevent the success of such a plan in wartime, Herr Heinrich Discher proposes that all war despatches shall be worked on the duplex system, that is, that whilst the real despatch is being transmitted in one direction along the wire, telegraphing shall also take place along the same wire in the opposite direction, so that both despatches being simultaneously transmitted will simply give rise to meaningless sounds in the telephone.

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[*] Among the latter may be consulted Miller "On Early Clyde-built Steamers," Trans. Inst. of Eng. and Shipbuilders, Scot., Vol. XXIV. p. 49; Sandham "On the History of Paddle-wheel Steam Navigation," Proc. Inst. Mech. Eng., 1885, p. 121. The interesting handbook for the collection of Marine Engine Models at South Kensington, by Mr. Holmes, the secretary of this institution, may also be read with advantage. A few of the particulars in this paper have been taken from proofs of this handbook, which have been kindly sent by Mr. Holmes.

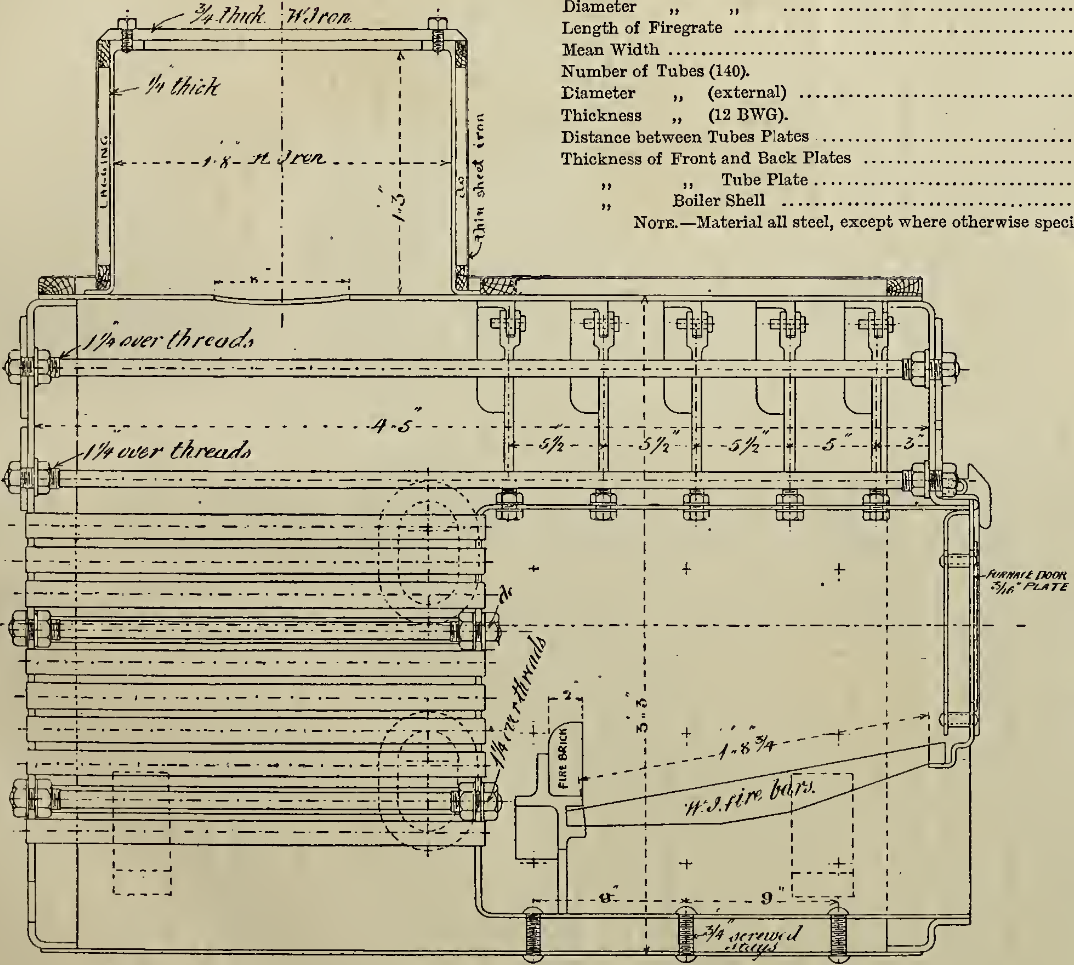
[*] For details of the developement of the marine engine in the British Navy, reference may be made to a series of articles in *The Engineer* for this year.

WORKING DRAWINGS.

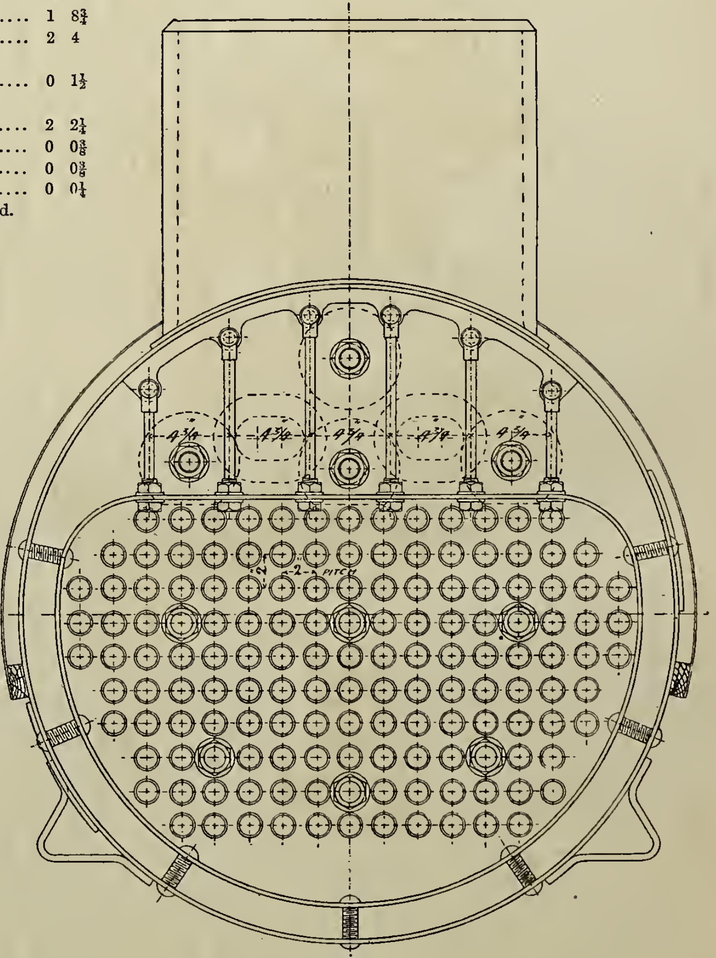
LAUNCH ENGINES.—VI. Details of Boiler.

	ft.	in.
Length of Boiler (outside)	4	5¾
Diameter ,, ,,	3	3
Length of Firegrate	1	8¾
Mean Width	2	4
Number of Tubes (140).		
Diameter ,, (external)	0	1½
Thickness ,, (12 BWG).		
Distance between Tubes Plates	2	2¼
Thickness of Front and Back Plates	0	0⅜
,, ,, Tube Plate	0	0⅜
,, Boiler Shell	0	0¼

NOTE.—Material all steel, except where otherwise specified.



Practical Engineer.



SAW-SHARPENING AND COLD-SAWING MACHINES.

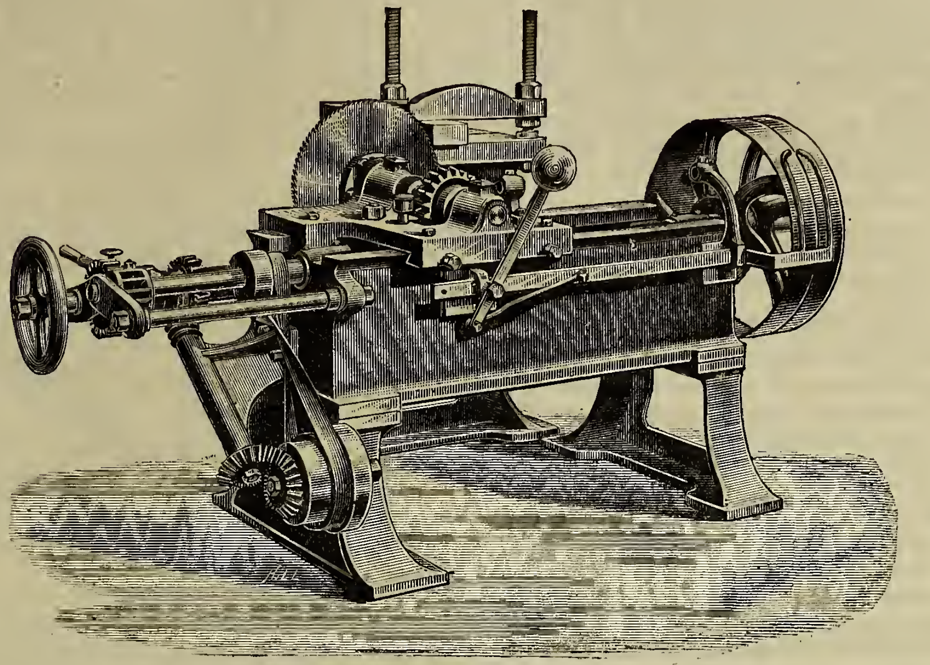


FIG. 2.—COLD-SAWING MACHINE.

WORKING DRAWINGS.

Launch Engine Boiler.

On the opposite page we give the sixth of the series of working drawings in connection with launch engines. The one now shown gives full details of the boiler, and as the dimensions are marked on so clearly, it is not necessary for us to go over them in detail. As will be seen from the drawing, the boiler measures 4ft. 5in. in length over all by 3ft. 3in. in diameter, the length of the firegrate being 1ft. 8¾in., and the mean width 2ft. 4in., thus affording a grate area of 4 square feet as nearly as may be. The smoke tubes, which are 140 in number, measure 1½in. diameter externally, and are made of brass, No. 12 B.W.G. in thickness. The top of the firebox, which is flat, is supported by 30 stud stays, secured to the firebox crown with double nuts and washers, and to the crown of the shell by pins attached to angle-iron ribs, as shown in the drawing. The top of the dome, which is of wrought iron ¾in. thick, is secured with set screws, so as to afford access for cleaning and examination. The boiler is constructed of steel throughout, the thickness of the cylindrical shell being ¼in., and of the front and back plates, as well as of the tube plates and firebox, ⅜in.

The illustration of the boiler completes this series of working drawings. The previous drawings, giving the details of the engines, appeared in our issues for June 29, April 27, March 23, January 20, and December 9.

SAW-SHARPENING AND COLD-SAWING MACHINES.

The illustration shown in fig. 1 represents an improved form of saw-sharpening machine, manufactured by Mr. Isaac Hill, toolmaker, of Derby, to which a brief allusion was made in the notice of the exhibits of the Royal Agricultural Show that appeared in our issue of the 20th ult. The advantages of automatic over hand sharpening, both on the score of rapidity and regularity with which the work is effected, are too obvious to call for comment, more especially as the system of cold sawing in engineering works is more and more resorted to. In the machine shown, an emery wheel is carried by the short arm of the lever, the long arm of which is connected to the crank on the revolving spur wheel; by this means the emery wheel is raised for the passage of the saw teeth. The long arm just mentioned is in reality a flat spiral spring, the flexibility of which prevents too much pressure being put on the teeth whilst sharpening, and thus avoids the "blueing" or softening of the saw which would otherwise result. The emery wheel will top the saw as well as sharpen the teeth, thus giving the trueness of periphery so essential for correct and good work with cold iron circular saws. The amount of the cut is regulated by means of the two hand wheels shown at the top of the frame, and when the machine is properly set the feed is regulated automatically, and it may be left to itself until all the teeth of the saw are sharpened, which it is stated to be capable of doing at the rate of 60 teeth per minute. The machine is well and strongly made, and is constructed in two sizes, the smaller being capable of taking saws from 6in. to 24in. diameter, while the larger will deal with diameters ranging from 12in. to 36in.

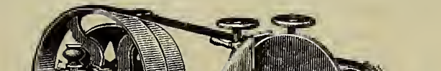

HILL'S PATENT
ISAAC HILL TOOL MAKER DERBY

Fig. 1.—Saw-sharpening Machine.

Fig. 2 shows a very useful machine for cold sawing. It is fitted with three speeds of self-acting feed, varying from 1½in. to ½in. travel per minute. The tool shown in the engraving will cut solids up to 3in. thick and girders of **Z** section up to 12in. by 5in. It is fitted with a self-acting quick return motion, as well as a self-acting disengaging motion and striking gear for belt. Each machine is fitted with phosphor-bronze driving wheel, while the bushes, shafts, and driving worms are all of mild steel. The saw is quite flush on the working side, being stiffened sufficiently by the boss on the machine side. The bolt heads are let into the saw so as to be flush with the surface, and thus enable the tool to get close up to its work, which is frequently of advantage, as in cutting off risers and other similar operations.

LESSONS IN MECHANICAL DRAWING.—XX.

By Prof. A. MacLay, B.Sc., C.E.

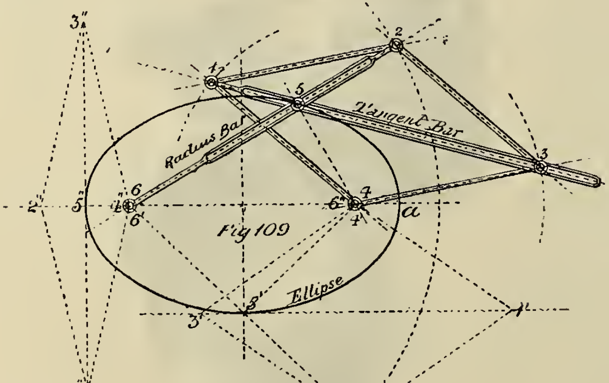
POINT PATHS *(continued).*

As an example which will bring the idea of a point path before the mind of the student in a practical form, I may here refer to an ingeniously simple instrument, called the conicograph; and as it illustrates the principle which runs through most of the preceding exercises, it may not be out of place to describe it at some length.

The conicograph is the invention of Mr. A. C. Campbell, of Bridgeport, Conn., U.S.A.,* and its object is to enable the draughtsman to describe those curves known as the "conic sections," particularly the ellipse, parabola, and hyperbola. The student, after working the foregoing exercises, will have no difficulty in recognising at once the principle upon which the conicograph works, viz., that of describing the path of a point moving equidistantly between a fixed point and a line or a circle.

In fig. 87 (p. 247) was shown the path of a point moving equidistantly between a fixed point and a line—the curve known as the parabola.

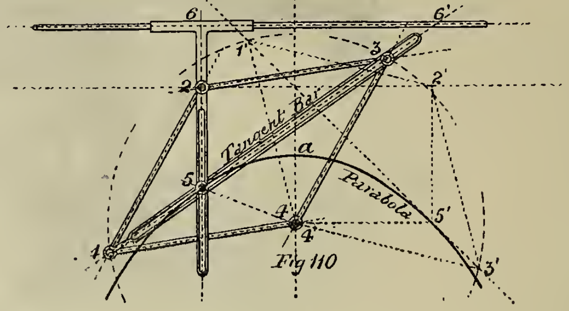
Again in fig. 95 (p. 307) was shown indirectly one case of the path of a point moving equidistantly between a fixed point and a circle, viz., the case when the fixed point is *without* the circle.



The other case—viz., when the fixed point is *within* the circle—has not previously been referred to. In the former case the path is a hyperbola (Ex. 86, fig. 95), in the latter an ellipse, as will be shown in connection with fig. 109.

Instruments have been devised for describing each of those curves; but the conicograph is perhaps unique in being able to describe all three. It consists of six links, four of which are connected together by pins and eyes to form the jointed parallelogram 1234, in the figures 109-10-11. The fifth link 13 is a diagonal of the parallelogram, and a tangent to the curve; hence referred to as the tangent bar. It is jointed by an eye to the pin at 1, and connected by a sliding piece to the joint at 3. The sixth link 256 forms the radius bar of the apparatus. It is connected with the tangent bar by a compound sliding piece at 5, which carries the describing point. It is further connected to the parallelogram at the pin joint 2, which describes the line or circle referred to in the second paragraph above; and lastly, it either turns round or slides along its other extremity at the joint 6. If we consider the straight line 22^1 of fig. 110 as an arc of a circle of infinite radius, then we may say 256 is a radius bar in all three examples, turning round about the joint 6 at its further extremity.

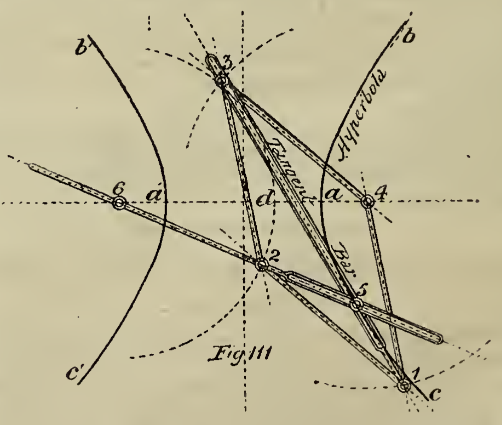
Since from the nature of the mechanism as so constructed the describing point at joint 5 can only move in the parallelogram along the diagonal 13, it is in all positions equidistant from the joints 2 and 4—the extremities of the other diagonal of the parallelogram. Thus it follows that if one of these joints is placed at a fixed point, while the other is made to move in a straight line or in a circle, that we have the conditions necessary for describing the required curves.



(*a*) By causing joint 2 to move in the straight line 22^1, fig. 110, and fixing the opposite joint of the parallelogram to turn round at 4, then the describing point at 5 will move equidistantly between the line 22^1 and the fixed point 4, and thus trace out a parabola.

(*b*) In fig. 109 the joint 2 is caused to move in the circle 22^1, while the opposite joint is fixed to turn at 4, a point *within* the circle 22^1. The result is that the describing point at 5, moving equidistantly as it does between the circle 22^1 and the fixed point 4 *within* it, traces out part of an ellipse.

(*c*) In fig. 111 the joint 2 again moves in a circle, viz., the arc 23, while the opposite joint is fixed to turn at 4, a point *without* the circle 23. The describing point at 5 now moves equidistantly between the circle 23 and the fixed point 4 *without* it, and thus describes a hyperbola.



Figs. 109, 110, and 111 are diagrammatic representations of the construction of the instrument. For the ellipse and the hyperbola the construction is the same, but the order of the joints on the radius bar is different, as it depends upon the relative position of the fixed point and the circle. For the ellipse 2 falls beyond 5, whereas for the hyperbola it falls within 5, the order in the one case being 652, and in the other 625.

For the parabola the radius bar is fitted with a **T**-head for sliding along the edge of a **T**-square or a straight-edge;

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* Trans. Amer. Soc. Mech. Eng., VIII., 145.

for 2, instead of describing a circle round 6, now moves parallel to it in the straight line 22^1.

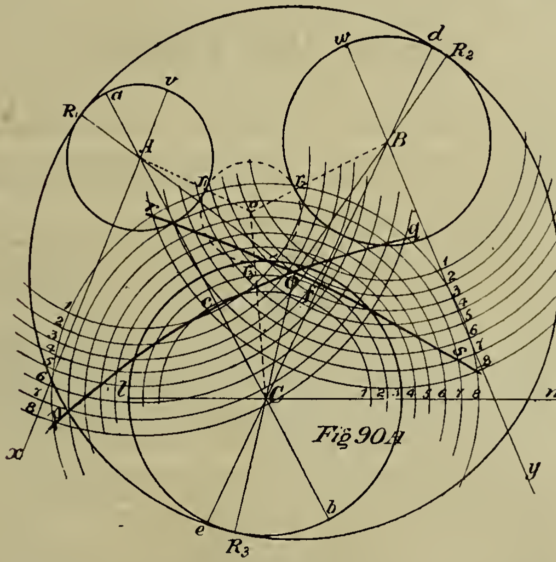
In fig. 109 one position of the instrument is shown at 1.........6, and a subsequent position at 1'.........6', when the describing point has passed from 5 to 5'. For the description of the left-hand side of the ellipse, joints 4 and 6 have to exchange places. The dotted fig. 1".........6" to the left shows the position of the instrument when the describing point is at 5". The same exchange of position has to take place between the joints 4 and 6 in drawing the left-hand curve in fig. 111.

A comparison between figs. 94 and 109 will show that the curves are identical. In fig. 94 the point moves according to the condition that the sum of its focal distances ($PF_1 + PF_2$) remains constant throughout. In fig. 109 the same condition holds good. For since distance 45 is always equal to 52, the sum of the distances 65 + 54 is always equal to 62, the radius of the circle 22'. The curve 55' 5" is thus an ellipse, and the centres 4 and 6 are its foci.

Also by comparison of figs. 95 and 111 the curves will be seen to be the same. For since, as before, distance 45 is always equal to 52, it follows that the difference of the focal distances 56 and 54 is constant throughout, viz., the part 26—the radius of the circle 23. The curve is thus a hyperbola, as explained in Ex. 86. Thus if two points be chosen as foci, an ellipse or a hyperbola may be described as the path of a point, which moves equidistantly between one of the foci and a circle described about the other as centre. When the radius of the circle is greater than the distance between the foci, the curve is an ellipse; when less, a hyperbola.

At the end of Lesson XVII, page 247, following Ex. 82, fig. 90, I ought to have completed the series by showing how to find the centre of a circle to touch three given circles. This is now given below as

Ex. 82A, Fig. 90A.—Given three unequal circles to find the centre of a circle to touch them (*a*) externally and (*b*) internally (*i.e.*, by circumscribing them).



When the circles are equal in diameter, the construction simply resolves itself into finding the centre of the equilateral triangle formed by the lines joining their centres. In the case of unequal circles the centres for the conditions (*a*) and (*b*) are different points.

(*a*) Externally: Find as in Ex. 80, fig. 89 (page 247), first the locus of centres of circles touching circles A and B, then the locus between circles B and C or C and A. These loci (not shown in the figure) intersect at the point *o*, and the points of contact are r_1, r_2, r_3.

(*b*) Internally: To find the centre of the circle which will circumscribe the circles A, B, and C. First find the locus of centres of circles to touch and include two of the given circles, say those with centres A and C. Proceed as follows: Draw the line *a b* through the centres A and C. Bisect *a b* at *c*. This must be one point on the locus, for if with *c* as centre and radius *a c* or *b c* we draw a circle, it will touch the one circle at *a* and the other at *b*. Through A draw any line *v x*, and through C draw a similar line *l m*. On *v x* and *l m*, beginning with a distance a little greater than *a c* or *c b*, mark off a number of points, 1, 2, 3, &c., making $v1 = l1$; $v2 = l2$; $v3 = l3$, &c. Then with centres A and C, radii A1, A2, A3, &c., and C1, C2, C3, &c., respectively, draw arcs, each pair of which will intersect at two points on the registered locus. Through these intersections draw the curve *p q*.

The locus *r s* between the circles B and C is found in precisely the same manner. The line *d e* drawn through the centres B and C is bisected at *f* for the middle point of the curve. Then distances $w1 = l1$, $w2 = l2$, $w3 = l3$, &c., are set off along *w y*. Then with B as centre, and radii B1, B2, and B3, describe arcs intersecting the corresponding ones drawn from centre *c*. The curves *r s* and *p q* intersect at O, which is the centre of the required circle, and lines drawn from O through A, B, and C cut the given circles at R_1, R_2, and R_3, the points of contact. Lastly, draw the required circumscribing circle from centre O, radius $OR_1 = OR_2 = OR_3$.

Ex. 12, fig. 80 (page 211), and Ex. 82A, fig. 90A, are extensions of the principle of construction shown in Lesson XI (page 28), figs. 65 to 68. By comparison, it will be seen that figs. 90 and 90A show the general method of which figs. 65 to 68 are particular cases, viz., that when the radius of the required circle is given. For example, notice that the method of finding individual points on the loci *p q* or *r s* in fig. 90A is exactly the same as that by which the point O in fig. 66 was determined.

CORRESPONDENCE.

We do not hold ourselves responsible for the opinions of our Correspondents.

SAFE WORKING PRESSURES FOR CYLINDRICAL FURNACES AND FLUES.

To the Editor of "The Practical Engineer."

Sir,—It is somewhat disappointing that a gentleman in the position of Mr. Michael Longridge should only be able, after taking the particulars of some 1,759 boilers, to place before the public an empirical formula, which, by his own admission, is only applicable within the very narrowest limits. It is further claimed that the formula is based upon an experience of upwards of 66,000 boilers, which, by the way, is a very large number; and until now I have been under the impression that the number of boilers at present on the books of all the boiler inspection companies in Manchester combined was scarcely so large as this; but probably a good few of the 66,000 have dropped out of existence for some reason or other. Yet even this large amount of experience appears insufficient, as the report says that "perhaps when all the boilers of which the company has particulars have been overhauled, some slight change in the constant may be desirable."

Reference is made in the early part of the report to the discrepancies in results obtained from three separate formulæ (1) Fairbairn's, (2) Fairbairn's modified, (3) Board of Trade. With respect to (1), this is, I think, generally admitted to be about obsolete, and may be passed over. (2) The constant 375,023 was, as might with justice have been mentioned by the writer of the report, introduced into Fairbairn's formula as being applicable to the long tubes of ordinary Cornish or Lancashire boilers, and the object in introducing it into the table of "discrepancies" is only too apparent. (3) Board of Trade rule. This rule was specially designed for marine purposes, in connection with which its application has been found by long experience to be thoroughly satisfactory, and was never intended to be applied to tubes 30ft. long. The writer of the report has also omitted to mention the existence of a short rule which has always to be used in connection with (3), *i.e.*, a rule limiting the crushing stress on the material to a certain amount, and which would probably have modified the number for the 5ft. tube very considerably.

Mr. Longridge, in his criticism on the foregoing three rules, makes some very cutting remarks about factors of safety. It is somewhat remarkable that the question of the factor of safety has been entirely ignored by Mr. Longridge. Perhaps it would be too much to expect this from a formula simply based on the average pressures at which a certain number of boilers are working; or perhaps the matter has not been thought worth mentioning. Nevertheless, it is a point of departure a number of engineers like to work from, when it can be got at with anything like certainty.

With regard to the formula itself I do not think there is much to be said. It will, I have no doubt, as stated by Mr. Longridge, give a "fair idea of the pressures at which long flues are usually worked." I do not quite see why L and L + 1 should have been used in determining the constants C and C1 in the tables. Why not have used the $\sqrt{L}$? The

$\sqrt{L}$ is used in the formula proper, because the constants in the tables' for the long and short tubes respectively, are found to vary as the square roots of the lengths, but the constants themselves are obtained by using L and L+1. It would, therefore, appear that the constant 50 in the formula proper has been deduced from numbers incorrectly obtained; anyhow, the conclusion is arrived at that the strength of flue tubes varies as the square root of the length, because certain numbers, which have been obtained by using formulæ in which the strength of a tube is as the "length" and as the "length+1" respectively, are found to vary in the ratio of the square roots of the lengths.

With regard to vertical boilers, it is suggested that a "slight correction" is necessary, and that the formula used should be:—

$$\text{Safe working pressure} = \frac{50t^2}{\sqrt{L+D}} - \frac{D}{L}$$

where t = thickness in thirty-seconds of an inch.
L = length in feet.
D = diameter in inches.

Now, applying this to the firebox of an iron vertical boiler of very common dimensions, both ashore and afloat:—

Diameter 40in., length 4ft., plate $\frac{1}{2}$in.,

We have the corrected formula:—

$$\text{Safe working pressure} = \frac{12800}{80} - \frac{40}{4} = \frac{12000}{80}$$
$$= 150\text{lb. per square inch.}$$

This gives a compressive stress on the material, under the working pressure, of 12,000lb. per square inch, just 50 per cent in excess of what has long been considered a reasonable maximum stress for short tubes of this description. It also gives—allowing compressive strength of wrought iron to be 15 tons—a factor of safety of 2·8. This, too, with a type of boiler that has for long enough, in both this country and the United States, topped the lists of boiler explosions.

Mr. Longridge "recommends the formula, with perfect confidence, as a guide;" and that "in ordinary iron flues, lap-riveted and nominally cylindrical, it may be applied unchanged. In other cases the pressure may be increased or reduced, &c., according to the judgment of the engineer. *No rule can possibly be laid down.*" To say that no rule can possibly be laid down for a furnace tube, other than an "ordinary iron flue, lap-riveted and nominally cylindrical," is absurd, and is a libel on the splendid engineering achievements of to-day. Surely it is not impossible to frame a rule making due allowance for a better design than that named, and for good workmanship.

I venture to think that if engineers had had nothing better to guide them than the empirical formulæ put forward by Mr. Longridge, high pressures, triple-expansion engines, &c., would never have met with that confidence and success that they have done.—Yours, &c.,

X. B. I.

TECHNICAL V. PRACTICAL EDUCATION.

To the Editor of "The Practical Engineer."

Sir,—I have patiently waited to see if any more able pen than mine would take up the case of our maligned engineers, and their declared inferiority to some of our neighbours, as evidenced by their entire ignorance of "logarithms," and consequent incapacity—in the opinion of Mr. Brunner—to design a "flywheel," even although the extraordinarily high salary of from £200 to £300 a year had been offered for this test of mechanical ability. Now, sir, I claim to be second to no one in my admiration of technical education—as shown by my presenting myself last session, at a mature age (not having had an opportunity earlier), for examination by the Science and Art Department in "Steam" and "Applied Mechanics." At the same time I cannot help seeing that the tendency of the present day is too much in that direction, to the neglect—and what is worse, the disparagement—of the practical, with the result that you will find men holding high and responsible positions dependent upon, guided, and consequently ruled by their employés, who are again, in their turn, influenced and controlled by their subordinates, until we find the workmen to be the real managers of the establishment. This is no fancy picture, but what I have actually seen abroad, so that when a competent practical man was put in charge, there was a saving effected in the first year of £30,000 sterling, and a great deal more work turned out.

It is not many months since an eminent German professor maintained that Germany was paying too dearly for her technical education, and that while they were speculating on probabilities, possibilities, and theories, other people were doing the work. And I think, sir, it is beyond all question that what I may truthfully call our acknowledged mechanical engineering supremacy has not been built upon the theoretical, technical, or scientific calculations and statements of our Tates and Rankines—however much we may admire them—but upon the practical and experimental knowledge and enterprise of our Watts, Whitworths, Nasmyths (not of logarithmic fame), Napiers, Stephensons, Fairbairns, &c., *ad infinitum*—men who perhaps had never heard of "logarithms," or at least, not until after their engineering abilities had been fully developed, and the works by which they are known to posterity achieved. There is no country more favoured in regard to technical education than Russia, where every works of any pretensions has its technical school attached—beside their technological institutes and engineering university; but as one of their own countrymen said to me, "Our engineers can tell the stars, but would not see a log of wood in their path until they had stumbled over it." I have myself seen young engineers with a superior technical university education begging bread and glad to take a shilling. No, sir, if we are to maintain our superiority it must be on other lines than those indicated by Mr. Brunner, but which the already too great length of this letter precludes me entering upon. Primarily, however, it must be upon a thoroughly practical acquaintance with our work, which is essential. At the same time I would strongly advise every young man, after he has acquired the necessary practical, to gain all the technical and theoretical knowledge possible, which is most useful and helpful. But when men in high places contrast us unfavourably with those whose technical education may be superior to our own, and insist that that superiority rests upon that training, then I for one refuse to admit the truth of either their premises or conclusions.—Apologising for the length of this letter, I am, yours, &c.

A. L. L. A.

Lancashire, August 15, 1888.

SPEED OF LOCOMOTIVES.

To the Editor of "The Practical Engineer."

Sir,—In last week's issue of your valuable paper you gave us your views of the dangers and difficulties to be met with by accelerating the speed of locomotive engines. Now, being a locomotive engine driver, and having been in the service for the last twenty-two years, you will perhaps allow me to give my opinion on the subject referring to the danger arising from derailment. You seem to have overlooked the fact that on sharp curves the speed has to be reduced to a certain maximum rate, thus dispensing with the idea of having two sets of roads, one for fast and one for slow trains, and I may say that this rule is strictly adhered to by all enginemen on curves of less than fifteen chains radius; but on all curves of a larger radius, with the proper safe elevation of the outer rail, I find in practice there is not the least danger of derailment from high speed, but rather that in rounding the curve we go much steadier (this is especially so in a curve of twenty chains radius), though I would certainly advocate the introduction of a guard rail on the commencement as well as termination of a curve, for in practice we know that it is at one of these points trains are liable to leave the metals.—Yours, &c,

Loco.

Aberdare, August 20th, 1888.

QUERIES AND REPLIES.

Drawing of a Pullman Car.—Could any reader inform me where I could get a working drawing of a Pullman car and a railway carriage?—E. P. S.

Answer.—A working drawing of a Pullman drawing-room car, and also of a Pullman sleeping car, appeared in our contemporary, *Engineering*, for April 2nd, 1875.

Pumping Water.—I have a 6¾in. Tangye pump pumping out of river 4in. suction pipe; distance between pump and river, 150 yards; rise, 12ft. If I put this pump on above a certain number of strokes per minute, say 30, the water piston falls half way into working barrel before reaching the water. At 30 strokes it works perfectly solid. Will someone kindly help me in this matter. I want to run 60 strokes per minute?—Tangye Pump.

Answer.—In reply to "Tangye Pump," his 4in. pipes are considerably too small for such purpose as he requires of them; but still I think he may get over his difficulty, as I have done in such a case, by inserting a partial vacuum vessel, similar to an air-vessel, in a vertical position, with one branch at its lower end connectcd to the suction pipe of his pump immediately below its lower clack, and another branch, also at its lower end, connected to the suction pipe from the river; the vessel being perfectly air-tight, and having at the least double the capacity of his pump barrel.—W. A.

Hauling Drum.—Thanks to "W. A." for answer to my question. Will he kindly tell me what he means by difference between pinion and drum spur wheel, so that they may run smoothly? Does he mean the teeth on pinion to be thinner, or what?—A Subscriber.

Answer.—In answer to "Subscriber," I beg to say that in order that toothed wheels may run smoothly together, it is necessary for the shape of the teeth of one wheel to have a certain relationship to the shape of those of the other wheel, and when the diameters of the two wheels are equal the teeth of each may be of the same shape; but the greater the disparity of their diameters the greater must be the difference in the shapes of their respective teeth; and in your case, where one is seven times the diameter of the other, the root or flank of the tooth of the smaller wheel, which is the weakest part of the tooth, is much thinner than the flank of the tooth in the larger wheel, and thercfore very much weaker, and iu consequence should be shrouded on both sides. Your brake ought not to act on or through your wheels, but be applied to the body of the drum, so as not to bring any sudden strain or shock on the wheels by its too rough application.—W. A.

Petroleum Engines.—Can you give me any information about petroleum engines, and the names of several makers. Whether, in your opinion, is a petroleum engine or steam engine the cheapest for five or six horse power, for general farm work, threshing, &c.? In winter it would be used about three days a week, and in summer would be almost idle. The ease in starting the petroleum engine would be a great point in its favour here. Distance from town three miles.—Petroleum.

Answer.—As far as simple cost of fuel is concerned the steam engine is undoubtedly the cheapest motor, but a steam boiler is a necessary adjunct of a steam engine, so that the question cannot be settled by simply considering the cost of the fuel alone, and it is probable that a petroleum engine would be better suited for your purpose. In deciding the matter a number of points require careful consideration. Messrs. Priestman Brothers make a small petroleum engine, and some particulars in regard to it were given in our issue of July 20th last, page 343, which may assist you in coming to a decision.—Ed.

Moment of Inertia and Radius of Gyration.—The meaning of these expressions, and an explanation of the uses of the formulæ, would be valued by Shiny Boots.

Answer.—The moment of inertia, as I understand it, is a certain quantity, constant for any body on a fixed axis, which depends (1) on the mass of the body, and (2) on the distribution of that mass about that axis. Its chief use is for enabling us to find the energy that the body is capable of storing up within itself when rotated about that axis. The radius of gyration is found as follows: If we divide the circumference of say a flywheel into any number of equal parts, find the centre of each part, and then draw a circle passing through all the centres of gravity, or as nearly so as possible, the radius of the circle thus described will be a little larger than the radius of gyration. The radius of gyration is such that it takes into account the masses of the arms of the wheel as well as of the rim. I believe the Greek root *gyro* signifies rotation.—Old Finsburian.

Answer.—The *moment of inertia* of an *indefinitely* small body or particle, relatively to a given axis, is the product of the mass of the body (or of some quantity proportional to the mass, such as the weight) into the square of its perpendicular distance from the axis; or

$$\text{Moment of inertia } I = \frac{w}{g} r^2, \text{ where}$$

w = weight in lbs.; g = gravity constant 32·2;
r = radius, or perpendicular distance from the axis in feet.

The *moment of inertia* of *any* body is the sum of the moments of inertia of all its parts, and is equal to

$I = \frac{w}{g} R^2$ where R is the *radius of gyration* and w and g have values as before.

The radius of gyration (R) of a body about a given axis is that length whose square is the mean of all the squares of the distances of the indefinitely small equal particles of the body from the axis, that is

$$R^2 = \frac{I g}{w}$$

In other words, the radius of gyration *squared* may be found (say, in the case of a rectangular laminæ, in which the axis is perpendicular to the plane) by dividing the whole area into a considerable number of squares of equal area, and then squaring the distance of *each* square, and afterwards obtaining *the mean* of the products thus obtained. With respect to the uses to which the *moment of inertia* and *radius of gyration* are applied, "Shiny Boots" has only to pick up almost any book of engineering formulæ, and he will without doubt soon find many formulæ which have for their basis the *moment of inertia.* For instance, *the distance of centre of oscillation or percussion* from the axis of a body is equal to the *quotient* obtained by dividing the moment of inertia of that body by the product of the volume of the body into the distance of the centre of gravity from the axis of motion. In calculating the deflection of beams, *the moment of inertia* due to the section of the beam is employed in the well-known formula—

$$D = \frac{w\,l^3}{c\,E\,I}$$

where I is the moment of inertia due to the section, and c a constant for each mode of supporting the beam and applying the load. In the case *of a rotating body,* the energy stored up in the same is equal to half its moment of inertia multiplied by the square of the angular velocity. The angular acceleration of a body moving about an axis = moment of forces divided by the *moment of inertia.* Summing up, we may say that the *radius of gyration* is that radius at which, if the *whole weight* of a rotating body were situated, the energy accumulated would be the same at the same angular velocity. Values of I and R for various bodies may be found in most books on mechanics.—Omicron.

Science and Art Examinations.—Will any reader inform me what books are recommended by the Science and Art Department for study in order to prepare for the subjects of "Steam" and "Applied Mechanics"?

Answer.—The Science and Art Department, in their syllabus, only point out the general subjects dealt with in the examination, and do not recommend any special books, and a better idea of the scope of the examinations could be formed by consulting the directory published by the Science and Art Department, the price of which is sixpence. As text books on the steam engine generally, you would probably find those by Goodeve and Jamieson useful. Seaton's Manual of Marine Engineering is also good, and you might, if sufficiently advanced, read Cotterill's and Rankine's books on the steam engine with advantage. "Applied Mechanics" is a very wide subject, and there is no text book which treats on everything dealt with in the examination. As text books, however, we may mention Anderson on Strength of Materials, Unwin's Elements of Machine Design, Goodeve's Principles of Mechanics, as well as his Elements of Mechanism; also Anderson on the Conversion of Heat into Work.—Ed.

Diameter of Flywheel.—Will some reader of your paper kindly inform me the best rule to calculate the diameter of a flywheel for an engine of a certain H.P., the solidity of its rim, also how to find power of an engine, say 60 H.P.—Zeta.

Answer.—I cannot say which is the *best* rule for the purpose "Zeta" requires, but Molesworth gives the following in his "Pocket Book of Tables and Memoranda":—

$$W = \frac{\cdot 6366\ PSC}{D}\left(\frac{N}{60}\right) \text{ where}$$

W = weight of flywheel *in tons*
P = pressure on piston in tons
S = stroke of engine in feet
D = mean diameter of rim in feet
N = number of revolutions per minute
C = constant, varying from 3 to 4 in ordinary engines, and rising to 6 when great uniformity is required.

He also gives the rule:—

$$W_1 = \text{weight of rim } \textit{in cwts.} = \frac{PS}{45\ D}$$

$$\text{Sectional area of rim in inches} = \frac{11\cdot 42\ W_1}{D}, \text{ when}$$

D and S have values as above, but P = total average pressure on piston *in lbs.*
The *mean diameter* D varies from 3 to 4 times the stroke of the engine.
For engines with high expansion, or with irregular loads, multiply W_1 by 1·5.
Another rule gives 100lb. weight *in rim* for every *indicated* H.P.

Professor Rankine's rule for weight of flywheel rim is as follows:—
Let D = diameter of flywheel in feet, measured to centre of rim
N = number of revolutions per minute
W = weight of rim *in cwts.*
V = variation of speed per cent of the mean speed

Then—

$$W = \frac{\text{I.H.P.} \times 65{,}800{,}000}{V \times D^2 \times N^3} \qquad (1)$$

and

$$W = \frac{AP_mS \times 4000}{V \times D^2 \times N^2} \qquad (2)$$

where AP_mS = area of cylinder in inches × mean pressure in lbs. × stroke in feet.
The above formulæ (1) and (2) are for non-condensing engines, cutting off at ⅓ to ¼ of the stroke.
For ordinary non-automatic expansion engines the constants in the formulæ may be ⅛th less.
The value of V, or the variation permissible in *portable* engines, should not exceed 3 per cent with an ordinary load, and 4 per cent with heavy load.
In *fixed* engines, for ordinary purposes, V = 2½ per cent or 3 per cent, and for *good* governing V = 1¾ per cent to 2 per cent.
Another rule which is much used is for engines up to 100 I.H.P.:—

$$\text{Number } \textit{of lbs.} \text{ weight in rim } \textit{per I.H.P.} = \frac{6{,}500{,}000}{N^2 \times D}$$

where N = revolutions per minute
D = mean diameter of rim *in feet.*

From the above selection "Zeta" will, no doubt, be able to choose one which will suit him. With respect to the latter portion of his query, if he will explain more clearly what he means by "finding the power of an engine, say 60 H.P.," I have no hesitation in saying that he will be able to get what he requires from some of the readers of "ours."—Omicron.

Fixing Propeller Shaft.—I shall be greatly obliged if you or any reader of your paper will inform me of the best method or the one mostly used on board ship to retain the propeller shaft.—H. B. C.

Locomotive Tube Plate.—Can any reader explain to me the reason of a locomotive tube plate cracking through the top row of tube holes at the smokebox end, and the plate bulging in ⅜in. after it has been at work. The plate is of steel, ¾in. thick, and the barrel is 3ft. 9in. diameter.—Locomotive

Helical Wheels.—Can any of my fellow-readers inform me of the best mode of setting out the teeth of a pair of bevel helical wheels, the larger wheel to be 34·8in. diameter, with 6in. face and 73 teeth, 1½in. pitch, and the smaller one or pinion 18·14in. diameter, with 6in. face and 38 teeth 1½in. pitch? Also a plain spur wheel 77·98in. diameter, with 140 teeth, 1¾in. pitch, to work in a pinion 40·1in. diameter, with 72 teeth. Any information with regard to making the patterns would oblige.—J. W. J.

Valve Diagram.—Would "Omicron" or some other kind reader favour me with a solution of the following? In a steam engine the cut-off takes place at ·7 of the stroke, the angle of lead = 6 deg., width of steam port = 1½in., and the steam port opens ⅘ of its area. Find by Zeuner's diagram (neglecting obliquity) the travel of slide, the angle of advance, the outside lap, and the outside lead.—C. J.

Navy Electrician.—Could you or any of your numerous readers give me any information as to the requirements of electricians in the Navy, and how one who has a good knowledge, both practical and theoretical, of electric lighting may become one?—T. H.

Cement for Brass.—Will you or some of your numerous readers kindly give me a recipe for or the name of the best manufactured cement for brass? I want to attach brass rings to the outside of a brass cylinder by means of cement.—Marine.

Starting Gear.—A sketch and description of "Brown's steam and hydraulic starting gear" would be appreciated by Shiny Boots.

Cast-iron Gutters.—Can any reader tell me the technical name of the cast-iron gutters that connect the down pipe from the roof to the gutters along the pavement of a road?—H. L. Crate.

Portland Cement.—I should be glad if some reader would tell me the strength of Portland cement for beams, and also for fireproof floors. I should also be glad of a section of a fireproof floor capable of bearing a load of 3cwt. per foot the floor having a span of 20ft. clear.—H. L. Crate.

Lift for Pump Clacks.—Will you oblige by giving the required lift for pump clacks or valves, and how to calculate the same in plain figures? Ex. 1.—For a 5in. ram pump, 2ft. 6in. stroke, running 30 revs. per min. Ex. 2.—For a 9½in. ram pump, 1ft. 9in. stroke, running 26 revs. per min.—Engine Attendant.

TO CORRESPONDENTS.

Training for Engineer.—In reply to "W. William," it is impossible to lay down a hard and fast rule with regard to the training best suited for an engineer. It entirely depends on what special branch of engineering you wish to follow; and you give no information on this point. Learning to be a turner and fitter will be calculated to give you a good insight into workshop practice generally, though the training in a torpedo factory would not, of course, afford you the same knowledge of the construction of engines and boilers as a shop specially devoted to this class of work. If you wish to rise above the ordinary level of a workman, you should also seek to obtain a thorough knowledge of machine drawing, as well as of the laws of heat and scientific principles generally.

Marine Engineer.—With your training, we should not expect you would experience much difficulty in attaining your objeect. You will find information as to the best course to follow by referring to the answer to "Intending Marine Engineers," given in our issue of March 9 last, page 119 See also answer to query by "Marine Engineer" in our issue for July 27.

Land Surveying Drawings.—In answer to "H. E. Lütte," we really cannot make head or tail of your question as to the "cheapest way to obtain land surveying drawings, with instructions how to work them." Pray what do you mean?

Finishing and Colouring Drawings.—The running of the ink lines experienced by "D. A." can be easily avoided by using waterproof liquid Indian ink. There are several makers of this, but we can speak from experience with regard to the excellence of that supplied by Messrs. Halden & Co., Albert Square, Manchester. The price, we believe, is a shilling per bottle. When once it is dry, there is not the slightest risk of the ink running, and the colour-brush may be washed over it with perfect impunity. If the ordinary Indian ink be used, the drawing should be lightly washed all over with a sponge, and allowed to dry before colouring is commenced. This is a much better plan than finishing the drawing in pencil and colouring afterwards. If the ink does not flow freely from your pen, it may be due either to the ink being too thick, or to the paper being greasy. If the latter, a slight touch of ox gall or soap in the ink would be of advantage. You will find very full information with regard to the colouring and sectioning of drawings in Lesson V., given in our issue for October 14th, 1887, page 457.

MISCELLANEA.

The Eiffel Tower.—In the construction of the Eiffel tower, at Paris, 2,500,000 rivets will be used.

Steam Power in France.—According to statistics issued by the French Ministry of Public Works, the number of industrial establishments employing steam power has risen from 29,000 in 1877, to 42,600 in 1887. A large development has taken place in the use of steam in agriculture, the number of engines employed for this purpose having risen in the same period from 4,800 to 13,000. The number of locomotives rose from 6,602 to 9,114. The number of steam ships has nearly doubled since 1877, there being now over 700 in the French mercantile marine.

To Render Brick Walls Damp-proof.—The *Wiener Gewerbe Zeitung* recommends the following plan for rendering brick walls damp-proof. The wall is first treated with a strong solution of soap and water, which is followed by a bath of a solution of alum consisting of 4oz. of alum dissolved in a pint of water. The walls to be treated should be clean and dry, and the soap solution should be applied as hot as possible, whilst the temperature of the alum solution should not be less than 70 deg. Fahr. The process should be repeated several times at intervals of twenty-four hours.

Water Power in the United States.—The American Statistical Association publishes some interesting figures on the amount of water power employed in the United States. In 1880 there was a total water power equal to 1,225,379 horses' power used for manufacturing purposes, this being 35·9 per cent of the total power thus employed in the States. The annual value of the water power thus utilised is set down at 24,000,000 dollars. The New England States alone use 34·5 per cent of the whole water power of the country, and altogether the Atlantic States use over three-fourths of the whole.

Russian Petroleum in Sweden.—Russian petroleum appears to have found a good market in Sweden, and the imports have already assumed important dimensions. The large and well-known Nobel establishment has just commenced the building of a large cistern for the storing of their petroleum at Vartan, close to Stockholm. The present cistern, which will be completed within a few months, and which is being built by the German firm of Seiffert and Melzer, has the shape of a cylinder. Its diameter is 60ft. and the height 30ft. It is the intention of Messrs. Nobel to build altogether five such reservoirs at Stockholm, two of which will be taken in hand next year, and two in the year 1890.

A Big Shot.—In continuation of a series of blasting operations, a big shot was recently fired at the limestone works of Messrs. T. Beswick and Sons, Peak Forest, near Buxton. Forty feet below the surface the rock had been tunnelled a course of 80ft., turning both right and left, and in a chamber at the extremity two tons of powder were placed. The fuse was fired by Mrs. Beswick, and the explosion, watched by hundreds of people who lined the hill-sides, occurred in 18 minutes. The rock lifted in the centre like a huge cone, and then fell in a broken heap almost ready for trucking. It is estimated that 50,000 tons was quarried, the experiment being every way successful.

A Large Dredger.—Messrs. W. Simons and Co., Renfrew, have just constructed a large barge-loading dredger to the order of Mr. T. A. Walker, contractor for the Manchester Ship Canal. The bucket ladder is adapted to work in a central well and cut its own flotation to a depth of fully 26ft. under water level, and it will have a raising capacity of 300 tons of *debris* per hour. The engines, which are also constructed by the builders, are of the compound surface-condensing type. The vessel was launched with its engines, boilers, and dredging machinery on board, and will leave the Clyde in a few days for Cardiff, where it will be engaged dredging in Barry Docks for a short time, and will then proceed to the Manchester Ship Canal.

A Dutch Engineering Prize.—The Royal Institute of Engineers, Dutch-East-Indian Section, at Batavia (says the *Indian Engineer*), offers a diploma and a prize of 500 guilders for a practical manual for the application of hygiene on building in Netherlands, India, judged worth awarding. The Association for the Advancement of Medical Science in Netherlands, India, adds a sum of 500 guilders to this prize. The judges will be composed of three members of the Royal Institute of Engineers and two members of the Medical Association, chosen by their boards. The manual may be written in the Dutch, French, German, or English language. The competition is open to all. All MSS. must be sent prepaid so as to reach the secretary of the East Indian Section of the Royal Institute of Engineers, at Batavia, not later than October the 1st, 1889. They must not be in the author's own handwriting. Each MS. is to be signed with a mark or proverb, and accompanied by a sealed note, on which is written outside the same mark or proverb, and a distinct mark for re-claiming them within, making known the name, quality, and residence of the competitor.

SELECTED PATENTS.

APPLICATIONS FOR LETTERS PATENT.

August 10th.

11527 Automatic Fog Signals, H. T. Grundy, Radcliffe.
11540 Breaking Cokes, T. Lees and R. Lees, Hollinwood.
11545 Lubricating Oils, C. H. Currie, Liverpool.—[Complete Specification.]
11562 Expansion Joint, E. A. Cowper, London.
11563 Steam Boilers, S. H. Smith and H. Lane, Middlesex.
11565 Extracting Metals, A. T. Wedelin, J. J. Robinson, and J. Gordon, London.

August 11th.

11583 Hydro-motor, T. Grainger, Glamorganshire.
11591 Punching Numbers, W. W. Popplewell, London. (W. Myers, United States.)—[Complete Specification.]
11595 Friction Clutches, J. S. Taylor and S. W. Challen, Birmingham.
11603 Ventilators, C. Darrah, London.
11609 Fixing Lids or Covers over Manholes, W. Jones, London.
11611 Belts or Straps, H. Ball and G. S. Hill, London.
11612 Machine for Doubling, P. Haddan, Middlesex. (E. Six, France.)—[Complete Specification.]
11613 Folding Apparatus, O. Imray, London. (R. G. Marsh, New Zealand.)
11614 Hydro-carbon Motors, A. G. Purchas and J. E. Friend, London.
11615 Exercising Machine. J. Ellis, London.
11616 Cement for Caulking, W. Watkins, London.—[Complete Specification.]
11617 Steam Boilers, C. Ward, London.—[Complete Specification.]
11619 Keying Wheels, H. Grafton, London.

August 13th.

11632 Combing Machines, J. Scott, Halifax.
11641 Carding Engines, T. Wrigley. Manchester.
11643 Steam Boiler Furnaces, J. Fernee, Norton.
11644 Steam and Hydraulic Stamps, J. S. Taylor and S. W. Challen, Birmingham.
11646 Slot-clamp Drawing Board, G. Cussons, Manchester.
11648 Flexible Metallic Pipes, M. D. Legat and L. J. S. Herbet, London.—[Complete Specification.]
11650 Compound Taps or Cocks, H. C. Willmott, G. Gillett, and C. E. Frank, London.
11655 Steam Engines, E. B. Edwards, London.
11656 Corking Bottles, A. Schünemann and C. Spindler, London.—[Complete Specification.]
11662 Dredgers, W. Shapton, Westminster.
11667 Hot-air Engines, E. Perrett, London.
11671 Ventilation of Tunnels, A. Kapteyn, Hampstead.
11672 Chains, C. Lock, London.
11673 Pliers, E. F. D. Neuff, London
11678 Seamless Tubes, W. Pilkington, London.

August 14th.

11689 Governors, R. Robinson, Salford.
11691 Consolidating Small Iron, T. Andrews, Manchester.
11692 Governor, R. J. Hunt and T. H. Harrison, Birmingham.
11700 Screw Propeller, W. H. Daniels, London.—[Complete Specification.]
11702 Motive Engines, E. Crowe, Middlesbrough-on-Tees.
11703 Electric Dynamos, E. Crowe, Middlesbrough-on-Tees.
11709 Pressing Bricks, N. Brooke and A. Taylor, London.
11711 Tubular Saws, T. Howe and M. Howe, Liverpool.
11712 Metallic Packing, W. B. Comming, Liverpool.
11714 Regulators, S. Davenport and E. Ingham, London.
11716 Economising Fuel, G. S. Hill, Bristol.
11729 Valve Gearing, A. Robert, London.—[Complete Specification.]
11730 Locomotives, M. G. Fuller, London.
11734 Burning Liquid Fuel, H. H. Lake, London. (B. A. Moody, United States.)—[Complete Specification.]

August 15th.

11741 Locks, W. P. Thompson, Liverpool. (H. V. Hœvenberg, United States.)—[Complete Specification.]
11745 Lubricators, F. W. MacDonald, Liverpool.
11746 Tuyeres, S. Pultney and J. Thomson, Glasgow.
11755 Looms, A. Sowden, Halifax.
11758 Cold-iron Sawing Machines, J. Hill and I. Hill, Derby.
11762 Man-hole Cover, E. Emanuel, London.—[Complete Specification.]
11771 Regulator, J. Crowther, London.
11773 Hot-air Engine, C. Wells and G. Clark, Middlesex.
11776 Flexible Metallic Tubing, F. J. Hadfield, London.
11779 Galvanometers, E. E. de Facieu, London.—[Complete Specification.]
11780 Brakes, A. F. Martens, London.
11786 Safety Lamps, V. Fumat, London.
11790 Gasholders, W. Ashmore, Westminster.
11791 Fastenings, W. Lindsay, London.
11793 Water Softening, C. E. Gittins, London.

August 16th.

11798 Electric Bell Fittings, W. Woodall, Middlesex.
11800 Union Joint, G. Wilson and G. F. Parkinson, Paddington.
11808 Machine Belting and Fasteners, H. B. Barlow and A. B. Barlow, Manchester.
11813 Centrifugal Fans, A. Lupton, Leeds.
11817 Electric Furnaces, J. C. Hobbs, United States.—[Complete Specification.]
11819 Taking-up Motions in Looms, S. Whitaker, London.
11825 Hydraulic Air Pumps, J. Miller, Middlesex.
11829 Railway Sleepers, W. E. Gedge, London. (J. R. Bell, India.
11835 Cut-off Valves, H. H. Lake, London. (W. W. St. John, United States.)
11842 Valves, E. Poppy, London.
11846 Rotary Concentric Piston Steam Engines, A. M. Clark, London. (G. N. Hubbard, United States.)
11847 Hot Air and other Motive Power Engines, J. Ellis, London.
11855 Open Hearth Furnaces, F. Siemens, London.—[Complete Specification

PUBLISHERS' ANNOUNCEMENTS.

BACK NUMBERS of "The Practical Engineer," from the commencement, can be obtained at either of our offices in London or Manchester, or by order of any Newsagent.

Vol. I. (bound), containing Nos. 1 to 44 inclusive, from March to December, 1887, price 6s. 6d., can still be obtained by order from any Newsagent, or will be forwarded, carriage paid, from either of our offices on receipt of the amount by postal order or stamps.

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EDITORIAL NOTICES.

All communications for the Editor of this Journal should be addressed to 6, Victoria Station Approach, Manchester.

Communications intended for insertion in the current week's issue should reach us not later than Tuesday Evening.

We cannot undertake to return rejected manuscripts or drawings unless accompanied by a stamped and directed envelope.

Contributors are requested to write on one side only of the paper. Sketches should be sent on separate sheets.

TO ADVERTISERS.

Advertisements intended for insertion in the current issue should reach us on Wednesday morning at the latest.

THE
PRACTICAL ENGINEER.
AUGUST 31st, 1888.

TECHNICAL INSTRUCTION BILLS.

Many of our readers may probably not be aware that the advocates of State-aided technical education have been again persistent in the present session. Two bills have been brought into the House of Commons, one by Sir Henry Roscoe and others, in February last, the second by Sir William Hart-Dyke and others, in May. These are a sequel to the bills of last session, one of which, the Technical Schools Bill for Scotland, became law; the other, a similar bill for England, was withdrawn. Though the two bills for this year have been withdrawn likewise, there remains the fact that in two successive sessions three Technical Instruction Bills for England have been introduced, passed a first reading, and been ordered to be printed. Of course the subject will crop up again, and for this reason we desire to invite the attention of our readers to the nature of the training which these bills will, if they become law, introduce into the board schools.

Technical instruction is defined by the bill of 1887 to mean "instruction in the branches of science and art with respect to which grants are for the time being made by the Department of Science and Art, or in any other subject which may for the time being be sanctioned by that department." In the first bill (February 10th) of the present year it means, in addition to those science subjects, "(*a*) the use of ordinary tools; (*b*) commercial arithmetic; (*c*) commercial geography; (*d*) book-keeping; (*e*) shorthand; (*f*) French, German, and other modern languages; (*h*) any other subject which the Education Department and the Science and Art Department jointly may from time to time prescribe as being a proper subject of technical education for the purposes of commerce, agriculture, or any trade or handicraft." In the second bill of this year (17th May) the scope is somewhat modified. "*Manual*" and "technical instruction" are coupled together; "manual instruction" means "instruction in the use of tools, and modelling in clay, wood, and other materials;" "technical instruction" means "instruction in the principles of science and art applicable to industries, and in the application of special branches of science and art to specific industries or employments."

In these acts the "local rate" is made chargeable with the cost of such education, and the "local authorities" are invested with the necessary powers for carrying out the provisions of the acts. The "local rate" in the several bills is variously interpreted to mean the school board fund, or the borough or local rate, or the general district rate, or the rate levied under the Public Libraries Act, which for the purposes of such education may be increased by one penny in the pound.

The "local authorities" are the school board, or the council of a borough, or the district council, or the urban or the rural sanitary authorities, or the authorities empowered to carry into execution the Public Libraries Act.

We have thus presented our readers with a condensed summary, omitting unnecessary details, of the scope of the Technical Instruction Acts. We cannot in the space of a paragraph or two discuss the very broad and, at present, experimental subject of technical education in general. We simply say here that, whatever its ultimate development, it cannot be successfully prosecuted on the lines laid down in these bills. It should ever be remembered that the true education of early life does not consist in cramming with information, but in a development of faculty—physical, mental, and moral—and in a broad instruction in leading principles. Cramming destroys confidence, and stultifies the faculty of independent thought. Education draws out, exercises the intellect, and develops capability—mental power. In these bills there is an attempt to cram—to teach more than a lad can profitably assimilate before the age of 13 or 14 years, and to foolishly anticipate the work of after-life. The teaching of the "use of tools," "modelling in clay," and so forth, could subserve no practical ends, and would waste most valuable time. Things of this character are properly learned during apprenticeship—a good old institution, the practical abandonment of which is an evil much to be deplored. Some folks are too eager, too hasty to remodel our institutions upon those of foreign countries. Imitations usually fail. We should improve rather than neglect our old apprenticeship system. Technical schools may be good for continental nations, but our apprenticeships have hitherto turned out the best mechanics in the world. Why abandon the system because it has been abused and neglected of late years? In itself it is admirable and sound, if only conscientiously carried out, and above and behind this we have our noble colleges, our Science and Art Department, and our technical schools, which, if not sufficient for our needs, are always capable of extension.

The authorities charged with the carrying out of the provisions of the Technical Instruction Acts are the members of school boards, urban and sanitary authorities, borough councils, &c., men who may be retired grocers, auctioneers, pastry cooks, butchers, publicans, members of professions—anything but competent to form a correct judgment as to the nature and value of the training required for special industries. The idea savours to us of the ridiculous.

Lastly, consular reports show that the question of success in trade is not one of the education of workmen, but of adaptability of manufactures, of business energy, push in foreign agencies, knowledge of conditions of trade, climate, and wants of people. It is really a question of commercial knowledge, tact, and business energy, rather than of technical training of workmen, 90 per cent perhaps of whom are mere "hands."

For these, among other reasons, we regard the whole subject of technical education as one for private enterprise, not for local boards or board schools, and, with Lord Armstrong, we hold that "it would be folly to rush into new and costly projects without any certainty of their resulting in adequate benefit."

NAVAL INEFFICIENCY.

Further evidence with regard to the unsatisfactory state of the machinery in our warships, to which we called attention in our last issue, is supplied by the correspondent of the *Times* on board the Ajax, and his remarks may be read almost as a supplement to the strictures contained in our article. Referring to the defective condition of the machinery revealed by the recent manœuvres, and the inadequacy of the engines and boilers to do the work expected of them, as well as the failure of the vessels to attain the hypothetical speed with which they are credited, the correspondent holds that the naval architects alone are responsible. For years, he says, they have been continually demanding of the engine builders lighter and lighter engines and boilers, and the endeavour to satisfy this craving for reduced weight is, he states, the main cause of the shortcomings that have been developed during the recent operations. To his own certain knowledge, writes the correspondent, "eminent firms have remonstrated with the Admiralty, and have pointed out that this perpetual craving for a combination of the maximum of power with the minimum of weight must lead to disastrous results, but in vain." Everything, he says, "has been cut down to such a degree that the limit of mere safety has been reached, if not overpassed. More especially is this the case with the boilers and steam pipes of our small cruisers."

Possibly the explanation of the defective state of things revealed by the correspondent may account for the small factor of safety adopted in boilers for the Admiralty, and which formed the subject of a paper by Mr. Richard Sennett, R.N., the head of the Admiralty engineering staff, at the spring meeting of the Institution of Naval Architects. An abstract of the paper and discussion thereon will be found in our issue for March 30th, as well as a letter from a correspondent singing himself "X. I. X.," criticising Mr. Sennett's conclusions, and commenting very strongly on the objectionable course the Admiralty were pursuing in cutting down the scantlings of naval machinery with a view to securing a reduction in weight.

The remarks made at the time by our correspondent, who is a gentleman exceptionally qualified to speak on the subject, possess additional interest when read in the light of recent events, and, indeed, anticipate very largely the criticism of the correspondent on the Ajax.

Limitation of weight may, no doubt, be a very desirable object to aim at in warship machinery, but it is very far from being the sole end to be kept in view; and when efficiency has to be sacrificed to attain it, it is very easy to see that too high a price may be paid. That the machinery in connection with our navy proved woefully inefficient during the recent evolutions is beyond dispute, and from what has been stated we think it is pretty manifest where one of the causes of the inefficiency lies.

THE RACE TO EDINBURGH.

With the close of this month, the London and North-Western and Great Northern Railway Companies intend to discontinue the accelerated express service between London and Edinburgh, which has excited so much interest in railway circles during the last few weeks. For the present it would appear that the two companies have agreed to cry quits, and in the forthcoming winter months the journey will be performed in 8½ hours, at what, after recent experience, will be considered the reasonable rate of 47 miles per hour, including stoppages. As this, however, will mean a saving of 1½ hours in the time occupied prior to the recent struggle for supremacy, passengers between the two capitals will have no reason to complain, and the journey will still stand out as by far away the greatest feat yet accomplished in railway travelling.

TRADES UNIONS AND THE EIGHT HOURS MOVEMENT.

One of the subjects for debate at the forthcoming Trades Union Congress, to be held at Bradford on the 3rd prox., is that of the limitation of the hours of labour to eight per day, and a somewhat lively discussion with regard to the question is anticipated. The matter was warmly debated at last year's congress, with the result that it was decided to submit the point to the test of a *plébiscite*. The delegates were pretty well agreed as to the desirability of limiting the length of the day to eight hours, and the only difference was as to whether the change should be effected by combination or by means of legislation. The *plébiscite*, it appears, has not taken place, the reason being, it is stated, that the Parliamentary Committee were unable to draft a voting paper that would please all parties. Since the last congress, the question has been extensively discussed by workmen, and a "Trades Unionist" writes to say that while unskilled labourers, including miners, are in favour of legislative interference, skilled workmen are, as a rule, opposed to it. It is becoming apparent, moreover, that while eight hours is a fair working day for some kinds of labour, a longer day might advantageously be allowed in some of the lighter trades, and there is a tendency manifested to seek the short day only for trades involving a heavy expenditure of physical energy. There does not, apparently, appear to be any disposition on the part of the workmen to suffer a reduction of wages in order to secure the proposed change. Altogether the question promises to afford scope for considerable discussion, and it will be interesting to note the development of the matter at the coming congress.

THE IRON AND STEEL INSTITUTE.

THE Autumnal Meeting of the Iron and Steel Institute has this year been held at Edinburgh, under the presidency of Mr. Daniel Adamson. This is the first occasion on which the northern capital has been selected as the place of meeting. Proceedings commenced on Tuesday, the 21st inst., by the reception of the members in the Senate Hall by Lord Provost Clark, as representing the municipality, and Sir William Muir, Principal of the University, accompanied by the staff of professors.

The Lord Provost, in giving a hearty welcome to the institution, called attention to the fact that in all the large schools in their city technical education formed a very important part of the instruction. He stated that there was not a large school in Edinburgh, either private or public, in which there was not a technical department, and during the last two or three years the old institution of Heriot's Hospital—a building which, he was sure, those of them who were strangers to Edinburgh would be glad to see, as being not only notable architecturally, but educationally—had been re-modelled, and, in union with the Watt College, a combination had been formed which would add very much to the technical instruction carried on in the city. The Engineering Department of the university had, he said, recently been fortunate enough to obtain a very large legacy, and he had no doubt that in consequence of this bequest that department, for purpose of instruction, would shortly be augumented in a very important manner. Although the city, he said, was not in such direct connection with the institute as such centres as Sheffield or Birmingham, yet there were many important manufacturing institutions in their midst, while the Forth Bridge, which was at hand, would afford them an opportunity of inspecting one of the greatest engineering works that had ever been constructed.

Sir William Muir afterwards welcomed the members of the institute to Edinburgh and its univerisity on behalf of the Senatus Academicus.

Mr. Daniel Adamson, in returning thanks to the Lord Provost and his colleagues for the kind reception, said that his predecessor, Dr. Percy, had requested him to express his obligations to the university, because it was just 50 years since he received his degree in that institution. Their ex-president, Sir Lothian Bell, was also educated at that university. Referring to the Lord Provost's allusion to the Forth Bridge, he could not help thinking that had it not been for the Iron and Steel Institute, and the leading members connected with it, the material of which the Forth Bridge was made could not have been produced, and the structure probably would not have been erected.

After the reception proceedings were over the members adjourned to the Examination Hall for the reading and discussing of papers. The chair was occupied by the president, Mr. Adamson, who was supported by Sir William Muir and Lord Provost Clark.

The President, in referring to the proceedings of the council during the past year, said their most important decision was the unanimous selection of Sir James Kitson, Leeds, to be their next president for the two years after May next. Another point the council had been called upon to decide was the place of next year's meeting. The question of visiting America had been brought before them, but as the Paris Exhibition was to be held next year, and the council had a very polite invitation to the French capital, they came to the conclusion that it would perhaps be desirable to visit Paris next year, and probably America in 1890. With regard to their proposed American visit, he thought it might be well to hear a few words from an American representative whom they had amongst them.

Mr. F. Sterry, New York, a member of the American Institute of Mining Engineers, explained the cordial feelings of his American brethren in reference to a visit from the British Iron and Steel Institute, and, referring to the proposed visit in 1890, said he could assure the institution a most hearty reception from their American brethren, and could promise not only such a reception as had never before been accorded to a scientific body in America, but an extremely profitable opportunity of studying the great mineral resources of the United States.

After the preliminary proceedings, the first paper read was one by the President, on

A HORIZONTAL COMPOUND-LEVER TESTING MACHINE.

The machine, the writer said, had a testing power of 15,000, and was fitted with a recording lever of 150,000 powers. It was composed of one strong box framing, and, being self-contained, only required a very light foundation, the object being more especially to prevent vibration, which might destroy the high sensitiveness of the machine when testing with great delicacy, the quadruple levers being inclosed in a box having glass sides, so that the operation might be seen, and in order to note the force by the floating weights on the fourth or registering lever.

The hydraulic cylinder was made of cast steel, with the valve seatings and water-ways worked out of the solid; and the power for testing was obtained by an hydraulic ram. The centres of motion of the pumps were directly opposite each other, so that one pump was constantly forcing whilst the other drew the water or other fluid from the box cistern, under the hydraulic ram cylinder. This gave a steady outward action on the ram, while the force was transmitted to the crosshead or grip box, holding one end of the specimen under test, through two steel side bolts, with adjustable screw ends, so as to regulate the distance between two sets of crosshead grip boxes to suit the varying lengths of test pieces, and to transmit the strain in a direct horizontal line—the opposite end of the test piece being fixed in the second crosshead grip box, attached to the main lever system, and the entire force being passed through the lever pins resting on hardened-steel knife-edges.

The crossheads were designed to take in specimens ranging from 6in. to 7in. in width. The first and main lever was a 10-power one of the first order; the second lever of the second order had 10 powers also; the third lever was of the second order with 12 powers; and the fourth and last registering lever was again of the first order, having 12½ powers—the total lever power thus secured being 15,000 to 1. In order to test up to the maximum power of 100 tons, four 3lb. weights were used at the end of the 15,000 power lever, each 3lb. in weight being equal to 45,000lb. on the specimen under test. The registering lever was divided and figured in divisions, which showed an increase of strain on the specimen of 1,000lb.; the minor subdivisions each gave an advancing record or decreasing load of 20lb., so that great refinement was secured with the traversing of a very light weight. The total weight required to register 228,000lb. was four 3lb. weights, used on the end of the 15,000 power lever, and one floating weight of 4lb., the aggregate of the weights used being only 16lb. The floating weight was traversed along the registering lever by a light cord, having a pulley fixed on the outer end of the lever, and another pulley against the outer end of the lever box; and by turning the latter pulley by the hand-wheel, the weight was traversed to and fro, so as to secure the necessary load on the test piece at any moment of time.

The object of this multiple-lever testing machine was to secure great sensitiveness with a considerable distance between the load and the fulcrum in each lever, the pull on the end of the lever being equal to ten or more powers.

The writer had made a series of investigations with levers of a largely-increased number of powers, so as to shorten the distance between the load and the fulcrum to a space not exceeding 3in., but in every case the friction was very much greater than when the levers were of lower power and longer distance between the load and the fulcrum. Short distances were therefore ultimately abandoned, and no lever in the present machine was less between the load and the fulcrum than 6in.

Where the machines were for higher power than 100 tons, the distances would be increased; and for 300-ton or 500-ton machines it would be desirable to have a space of not less than 10in. between the load and the fulcrum, so as to get enlarged pins, with strength to resist the load that it might be desirable to put on the test piece, and thereby to reduce the lever friction on the knife-edges to a minimum.

The advantage of the high powers of the multiple-lever machine over the small power did not end with simplicity of construction, inasmuch as by the compound system the space passed through by the end of the registering lever was as 15,000 to 1; or, supposing that the end of the lever with the detached weights on the scale-plate moved through 1in. of space, the grip box that transmitted the load to the first main lever only moved 1-15,000th of an inch, the space being so small as to reduce the friction to a minimum.

The machine was arranged for testing transversely in lengths of 3ft. downwards, and also for compression and punching; but each system required a small modification and additional apparatus to carry out these tests.

To ascertain with greater rapidity what had taken place as the force was put on the test piece, an additional recording 10-power lever was fixed on the top of the lever box. This additional recording lever was designed simply to detect more quickly and more easily the force that was being put on the specimen, and to obtain the highest refinement of the first or main lever, thus precluding the possibility of producing abrasion on the knife-edges by any undue motion. It was found that when the end of this lever moved one inch the specimen was affected to the extent of only 1-150,000th of an inch. If greater refinement were the object of the test, then the record indicator lever could be observed when it moved a tenth of an inch, as was marked on the recorder plate.

To pass again backward to the specimen, when this recording lever had only moved one-tenth of an inch, the specimen must be subject to a disturbing influence of only 1-1,500,000th of an inch; and presuming that the test piece then being investigated was 10in. in length, it would be impossible that it could be influenced further than 1-15,000,000th of an inch per inch in length without being noticed. Such a refinement of action could be got through this system of levers, that if one blew upon the scale weight plate at the end of the fourth lever, one produced a sensible effect on the whole system, and a disturbing influence on the specimen itself.

As illustrative of the work performed by the machine, a plate was designed to show the full-size dimensions of a test piece of mild steel equal in cross-section to a square inch of area. Another figure applied to the same specimen tested to destruction, on which permanent set was developed by a force of 18·12 tons. This specimen carried a maximum load of 27·23 tons, at which point it had elongated 18 per cent, after which local elongation set in, and less and less weight was carried, until the specimen was broken with a load of 20·08 tons, and with a total elongation of 26 per cent—a good average specimen of soft mild steel. Still another figure showed an unbroken specimen that took permanent set at 17·41 tons. The load was increased up to 21·42 tons, under which force it had stretched 5 per cent; the specimen was then removed and annealed. After being annealed nine times, it took permanent set at 9·37 tons, and carried a maximum load of 10·26 tons, at which point it had elongated 53·5 per cent. A similar specimen, beginning with one square inch of sectional area, was annealed twelve times. It took permanent set in its normal condition with 17½ tons, at which point it had elongated 6·375 per cent. After the twelfth annealing, it took permanent set with 8·66 tons, and pulled asunder with 11·33 tons, with a reduced sectional area of 0·2739. The total elongation when rupture took place was 76·5 per cent. It was worthy of observation that, on the sectional area being reduced to 0·2739, the maximum load carried was 11·33 tons, being equal to 41·36 tons per sectional inch.

The commercial value of these investigations might not appear to be of great importance. To some extent, however, they were of value, because if a chain was loaded to its maximum carrying power, and left alone, any further increase of load would cause it to rapidly break down; but if first annealed, and the tests showed that a greater carrying power was obtained on the first and second annealing than in the normal condition of the metal, chains might not only have their strength restored, but even somewhat increased, by following this annealing process. The record of these facts might be equally advantageous for other purposes that at the moment did not present themselves to the mind of the investigator, and as the operations were carefully conducted, they would remain as a record for consideration and guidance.

The writer did not claim to be the author of the multiple-lever testing machine. In the earliest investigations a single lever was used, the load being measured by suspending 56lb. weights, and when the full load was put on the specimen instant rupture followed, the load not being capable of being reduced as the breaking elongation took place. This latter principle was made known by the writer in the paper which he read before the institute at Paris in 1878.

The American "Emery" machine that was now being exhibited in London was also a multiple-lever apparatus, but it had two hydraulic chambers with reducing areas, as 1 was to 20—the lever system being as 1 was to 20,000—making the total ratio of the hydraulic chambers and the lever system together as 1 was to 400,000; and it was reported that the motion of one-millionth of an inch on the specimen produced a motion of the indicator rod of four-tenths of an inch. This high indicating power would be found of great value in noting the amount of force necessary to produce permanent set.

The earlier tests made by Mr. Kirkcaldy in Glasgow were with a single-lever machine, but he no doubt saw the necessity of greater accuracy and higher refinement. The writer believed that Mr. Kirkcaldy was the first to adopt the multiple-lever system, and his tests were taken as the standards of accuracy by the whole of the professional community.

The discussion on Mr. Adamson's paper was opened by Mr. Wicksteed, of the firm of Messrs. Joshua Buckton and Co., Limited, Leeds. He pointed out that the author had not described how he verified his machine, and held that there was always in the case of a horizontal machine more difficulty in verifying than in the case of a vertical machine. Supposing there was an error of 100th between each fulcrum distance, when they multiplied their levers they added these errors one to the other. The Board of Trade would not admit machines which had a leverage ratio of more than 100 to 1. As to the value of multiplying the motion at the end of the fourth lever as indicating precisely the motion of the specimen, he did not think that because the lever ratios were 15,000 to 1, that therefore one inch of motion at the end of the fourth lever would precisely measure the 15,000th part of the specimen, because of the flexure of the levers. He might say that he himself had been moving in the exact opposite direction to Mr. Adamson. Mr. Adamson began with a compound-lever machine, and he had moved further in the same direction, increasing the leverage ratios. He (Mr. Wicksteed) had been moving in the contrary direction, and with very good results. To illustrate his remarks, he would say that Mr. Adamson employed a mass of sixteen pounds to measure a hundred tons. He (Mr. Wicksteed) employed a mass of five tons to measure a hundred tons, so that he only multiplied the mass that he used fivefold. He also held there was almost no such thing as friction on a well-constructed knife-edge. It was hard, and it simply vibrated. He agreed in some measure with Mr. Adamson in saying that the fulcrum distance should not be made too close, but of course that was a question of degree. The degree that had been prescribed by the Board of Trade in the rules under the Act of Parliament was that in a 100-ton machine the fulcrum distance must not be less than four inches. He had worked with a fulcrum distance of four inches, and the machine vibrated through a considerable angular distance without any ascertainable resistance ensuing from the action of the knife-edged fulcra.

Mr. Hemming, New York, said that although there were a great many interesting points in connection with the machine, there were a great many which might be criticised, not from theoretical principles, but from practical experience alone. Mr. Hemming went on to indicate certain objections to the multiplication of levers. He argued, in effect, that the multiplication of levers increased the liability to error. He held also that the greater the fulcrum distances, the greater the deflection; and it was against deflection that they had to guard. A good knife-edge would work admirably, he said, for some time, but they must know when those knife-edges began to change. Indeed, he thought that the fewer knife-edges they used, the better, as a rule.

M. Gautier, Paris, said the only testing machine upon which they could rely must, in the first place, be acted by hydraulic power; in the second place, the action of the pumps must be regulated by a compressor; and, in the third place, the weight which was applied to the specimens must be tested by a column of mercury and water.

Mr. P. F. Nursey, London, described certain tests that he had carried out upon samples of tempered glass, and took occasion to confirm what the president had stated as to Kirkcaldy being the first to adopt the multiple-lever system.

The President, in reply, said he could not agree with all the advice they had got about levers being subject to tension and to mechanical disturbance. The question with him was—Is this multiple-lever system accurate, and can its records be traced upwards and downwards by any system of check? He had got with him a specimen subject to investigation of this sort, and by placing this in a machine one inch in length and one-quarter square inch in area, he could get a sensible effect on the recording lever by gripping the piece of steel in his hand, and then, by taking it away again, leaving sufficient time for it to get at rest and the temperature to return to a normal condition. If such a record could be got and repeated time after time, he thought they were satisfied that the temperature expansion could be registered and written off, and he thought there was very little risk that any disturbance of tension or deflection of the levers was going to disturb the accuracy of the machine.

(To be continued.)

The Italian Navy.—A new cruiser for the Italian Government, named the Piemonte, has just been launched from the shipyard of Sir W. G. Armstrong, Mitchell, and Co., at Elswick. Her approximate dimensions are—length 300ft., breadth 38ft., and depth 23ft. She is of about 2,500 tons displacement, and carries engines of about 12,000 indicated horse power, which it is reckoned will give her on trial a speed of over 21 knots. When completed it is thought that she will prove the most powerful war cruiser of her size and pattern. It is expected that the Piemonte will be finished and ready for departure from the Tyne by the end of the year.

WHITWORTH AND NATIONAL SCHOLARSHIPS, 1888.

The list of successful candidates in the competitions for the Whitworth and National Scholarships, at the recent May Examinations, has just been issued by the Science and Art Department. The arrangement in connection with the Whitworth Scholarships has this year been considerably modified, and, to our mind, very much improved. The practice of distributing a portion of this endowment in the form of simple money prizes has been discontinued, and the scholarships and exhibitions are only tenable on condition that the holder continues to prosecute his studies. If we had to suggest any improvement in the present arrangement, it would be in the direction of increasing the number of scholarships tenable for three years, and reducing the number of annual exhibitions.

The following are the results of the examinations :—

Whitworth Scholarships of the Annual Value of £125 Tenable for Three Years.

J. Whitaker, 22, student, Nelson, Lancashire.
J. Mair, 22, engineer, Glasgow.
C. H. Gilbert, 22, engineer student. Nottingham.
J. Calder, 21, mechanical engineer, Glasgow.

Whitworth Exhibitions, Tenable for One Year, and of the Value of £100.

H. Bamford, 22, engineering student, Oldham.
J. Harbottle, 21, draughtsman, Newcastle-on-Tyne.
J. Taylor, 21, engineer, Glasgow.
J. Dalglish, 24, mechanical draughtsman, Paisley.
A. S. Younger, 23, engineer student, North Shields.
J. Butterworth, 22, engineer, Rochdale.
G. A. Burls, 21, mechanical draughtsman, Greenwich.
C. H. Kilby, 20, engineer apprentice, Crewe.
C. R. Pinder, 21, engineer student, Bristol.
R. Dumas, 22, engineer, Glasgow.
C. L. E. Heath, 21, fitter apprentice, Devonport.
C. Forbes, 21, engine fitter apprentice, Glasgow.
B. Young, 23, electrical engineer apprentice, Belfast.
E. Y. Terry, 23, engine fitter, Devonport.
W. J. Collins, 23, draughtsman, Woolwich.
J. H. B. Jenkins, 21, assistant analytical chemist, New Swindon.
J. I. Fraser, 24, apprentice engineer, Glasgow.
H. E. Cheshire, 24, fitter, Crewe.
O. Brown, 23, pattern maker, Plumstead.
H. Elliott, 25, mechanical engineer, Glasgow.

Whitworth Exhibitions, worth £50.

J. H. Binfield, 23, engineer student, Preston.
G. U. Wheeler, 20, engineer apprentice, London.
W. Day, 22, fitter, Wolverton.
S. Dea, 25, turner, Crewe.
E. Parry, 22, engineer student, Bangor.
T. O. Mein, 23, engineer, Stratford.
B. Conner, 23, apprentice engineer, Glasgow.
T. J. Bourne, 23, marine engineer, Tunbridge Wells.
G. Ravenscroft, 25, fitter, Crewe.
T. F. Parkinson, 22, engineer student, Bury, Lancashire.

ROYAL EXHIBITIONS, NATIONAL SCHOLARSHIPS, AND FREE STUDENTSHIPS.

The successful candidates in these competitions are as follow :—

National Scholarships.

J. B. Coppock, 23, student, Nottingham.
J. G. Lawn, 20, mining surveyor, Barrow-in-Furness.
H. Grime, 19, teacher, Manchester.
A. Stansfield, 17, student, Bradford.
J. Eustice, 24, engine fitter, Camborne.
E. Wilson, 19, student, Bradford.
L. M. Jones, 18, student, Llanelly.
J. Jefferson, 20, student, Bradford.
H. T. Bolton, 15, student, Newcastle-on-Tyne.
B. Howe, 18, student, Manchester.
J. Yates, 20, draughtsman, Manchester.
H. Cavendish, 17, student, Manchester.

Royal Exhibitions.

T. S. Fraser, 17, laboratory assistant, Glasgow.
B. Young, 23, electrical engineer apprentice, Belfast.
J. Harrison, 29, shoemaker (riveter), Northampton.
J. D. Crabtree, 16, student, Bradford.
J. Burton, 19, student, Manchester.
J. Taylor, 21, engineer, Glasgow.
J. Husband, 17, student, Sheffield.

Free Studentships.

T. Beatham, 16, student, Newcastle-on-Tyne.
C. H. Kilby, 20, engineer apprentice, Crewe.
G. H. Gough, 17, student, Bristol.
H. E. Cheshire, 24, fitter, Crewe.
E. W. Rees, 20, engineer apprentice, Carnarvon.
S. H. Ford, 17, student, Bristol.

A NEW RUSTLESS COATING FOR IRON.

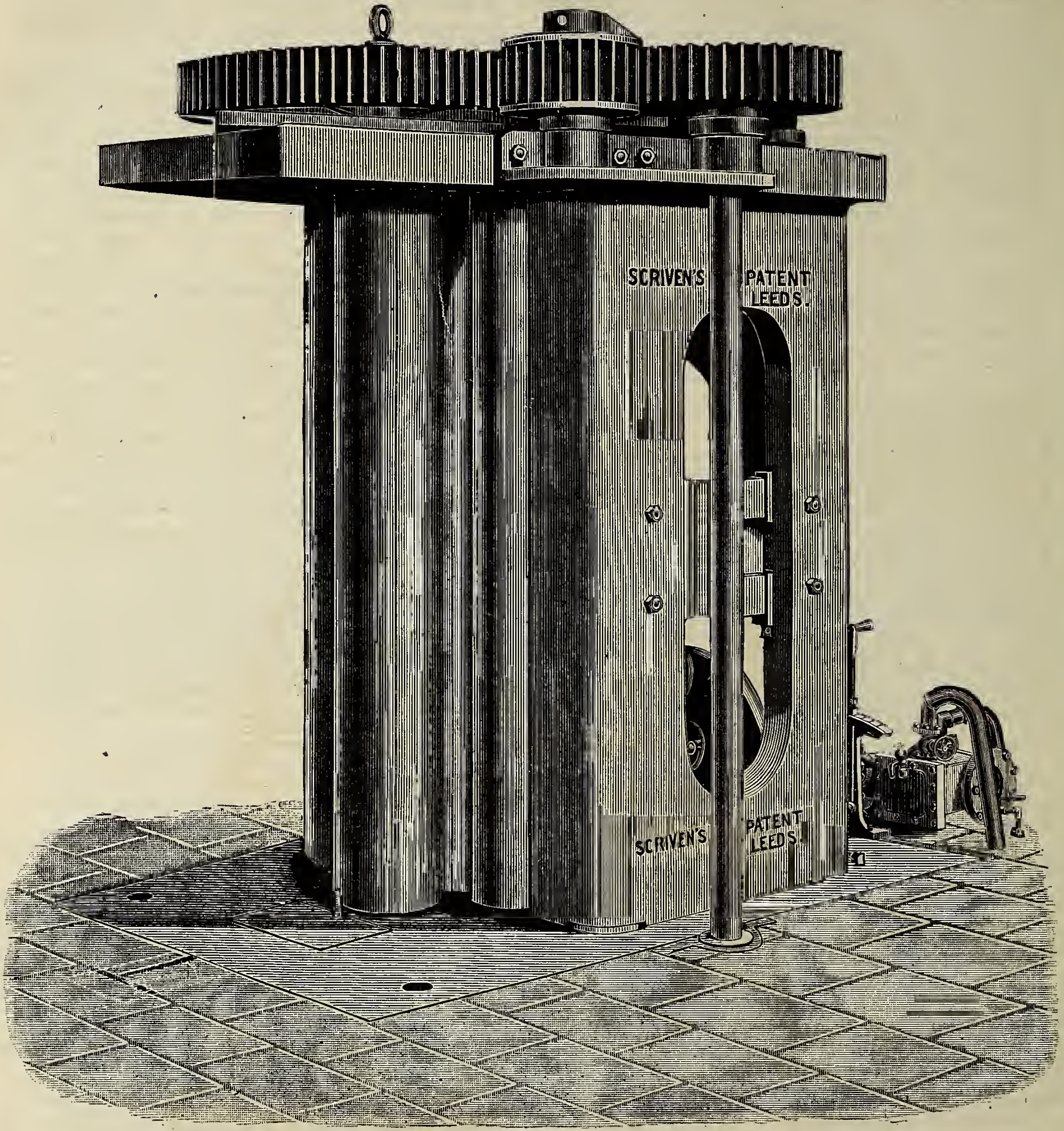
Mr. H. Haupt describes a process for protecting iron against corrosion, now employed by the Hydrogen Company of the United States, at Port Chester, Pa., which is said to give satisfactory results. The company is now manufacturing sanitary soil-pipes treated by this method, which is described as follows :—" After the pipes have been lowered into the retorts by means of a traveller, the retorts are closed for about fifteen minutes until the contents are heated to the proper temperature. Steam from a boiler at 60lb. pressure is then introduced into the superheater, which it traverses, and from which it escapes at a temperature of the iron upon which it acts for about one hour. A measured quantity of some hydrocarbon is then admitted with a jet of steam, followed again by a fixing bath of superheated steam, which completes the process. Professor Gesner, the director of the works, says there is no pressure in the retort, and that there are no free explosive gases. The water seals attached to the retorts show only slight oscillations, but not an inch of pressure, and when the covers are removed and air admitted there is no explosion, as there always is when free hydrogen or carbonic oxide are present. The absence of pressure and of explosive gases is a proof that all the operations have been so nicely regulated as regards material used, quantity and time of application, that a perfect absorption and union of carbon, oxygen, and hydrogen with the iron has been effected. The protection thus afforded to the iron is not a mere coating, like paint, but is said to be an actual conversion, to a greater or less depth, into a new material. When properly treated, this material does not seem to be detachable by pounding, bending, hammering, rolling, or heating. The pipes treated at Port Chester have been immersed in baths of dilute sulphuric acid and exposed to the salt air for weeks without change, while untreated pipes were quickly covered with red oxide or with sulphate of iron." This process makes claim to advantages over the Bower-Barff in making a coating that does not crack, and is more resisting.

THE PANAMA CANAL WORKS.

An American engineer, who visited the Panama Canal works in 1885, and made another visit to them last July, thus summarises, in the New York *Engineering News*, the general impressions he formed of the methods and progress of the works :—

The unavoidable impressions gained from the four days spent in watching the work are of non-effectiveness, and that, in spite of the immense amount of costly machinery and plant which has been sent to the isthmus, the work is being done by hand labour. There is not a power drill, as far as I could learn, in operation on the isthmus. At Obispo there is a gang of men carrying rock from the cut upon their backs, in kerosene oil tins. As far as my observation goes—and I was over every section where any work is in progress—there is not an excavator on the isthmus that is doing excavation work ; they are simply elevators transferring material previously excavated by hand to the cars, and doing this in a very wasteful manner. There is no responsibility or accountability for material or work. As a result of the method of letting work in each section to many different contractors, without (apparently) any restrictions as to dumping ground, instead of letting an entire section to full depth and width to one party on carefully digested studies of where every yard of earth should be deposited, fully 90 per cent of all material excavated is handled twice and three times. Most of the excavating and dumping plant is badly deteriorated, and should the work continue a year longer, nearly if not quite all of it will have to be replaced. The intention in regard to the locks is evident ; they are to be the trump card ; the public is to be kept informed of progress upon them ; they will be represented as all that remains to be done to enable the canal to be opened ; and when they are completed it will be heralded with a grand flourish of trumpets, and a call will be made upon the "faithful" for money, for "maintenance" perhaps ; the fact that millions of cubic metres yet remain to be excavated before even a tadpole could navigate from lock to lock being serenely ignored. The locks will take the place of the "finished section" as the company's *piece de resistance.*

VERTICAL PLATE-BENDING MACHINE.


SCRIVEN'S PATENT LEEDS.
SCRIVEN'S PATENT LEEDS.

THE illustration given above represents a patent form of plate-bending machine, made by Messrs. Scriven and Co., of Leeds. The tool possesses several novel features which specially commend it to the notice of boiler-makers and shipbuilders.

As will be seen from the engraving, the rolls, instead of being fixed horizontally, as in the ordinary arrangement, are fixed vertically, which is a decided advantage, especially considering the large plates now dealt with, and the endeavour, whenever possible, to bend the shell plates of boilers so as to form the entire circumference in one plate. The difficulty of manipulating the shell plate of the boiler (8ft. in diameter) with the ordinary horizontal arrangement of rolls, and the tendency of the plate to "sag" and distort the curvature, will be manifest to all who are familiar with plate bending. But with the vertical arrangement of rolls this difficulty is of course entirely obviated, as the plate stands edgewise on the floor, and the necessity for crane manipulation is largely dispensed with.

Another advantage attained in the arrangement shown is that of being able to bend the plate to the required curvature right to its extreme end. With the horizontal arrangement of bending rolls adopted in many shops this is not possible, and sometimes to complete the bending the end of the plate is subjected to rather savage treatment with the sledge-hammer. The danger which may result from this treatment, especially with plates of an inferior quality, was pointed out in our issue of July 6th, in referring to the explosion of a comparatively new boiler. (See page 314.)

The method by which the bending of the plates is effected in Messrs. Scriven's machine will be best understood by reference to fig. 1, which gives a sectional plan of the arrangement of the rolls. It will be seen that there are four rolls instead of three as in the ordinary arrangement. The front and back rolls of a machine suitable for dealing with plates, say up to 5ft. 6in. in width, by 1¼in. in thickness, are of forged steel, 17½in. in diameter, and are used for pinching the plate. The setting rolls on each side are of cast iron, 12in. in diameter, and the amount of set is regulated by means of powerful screws worked from the back. In curving the plate it is bent one end at a time. Thus, to bend the left-hand end, the right-hand side roll is set up and the plate passed from left to right. The plate being held between the front and back rolls and the right-hand side roll, the bending action continues as long as the plate is held between the front and back rolls—that is, to the end of the plate. To bend the other end of the plate, the right-hand side roller is withdrawn, the left-hand one set up, and the motion reversed.

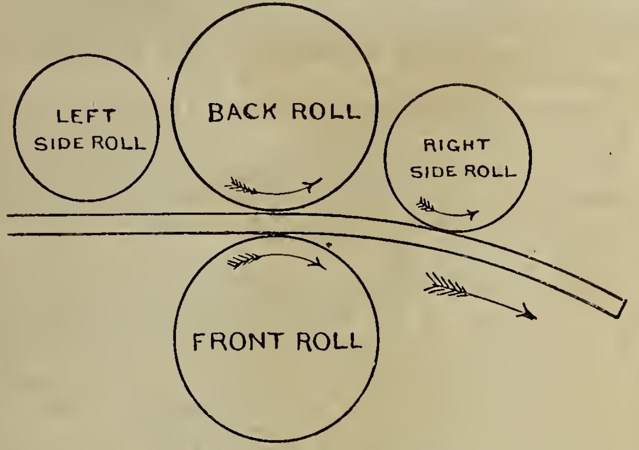
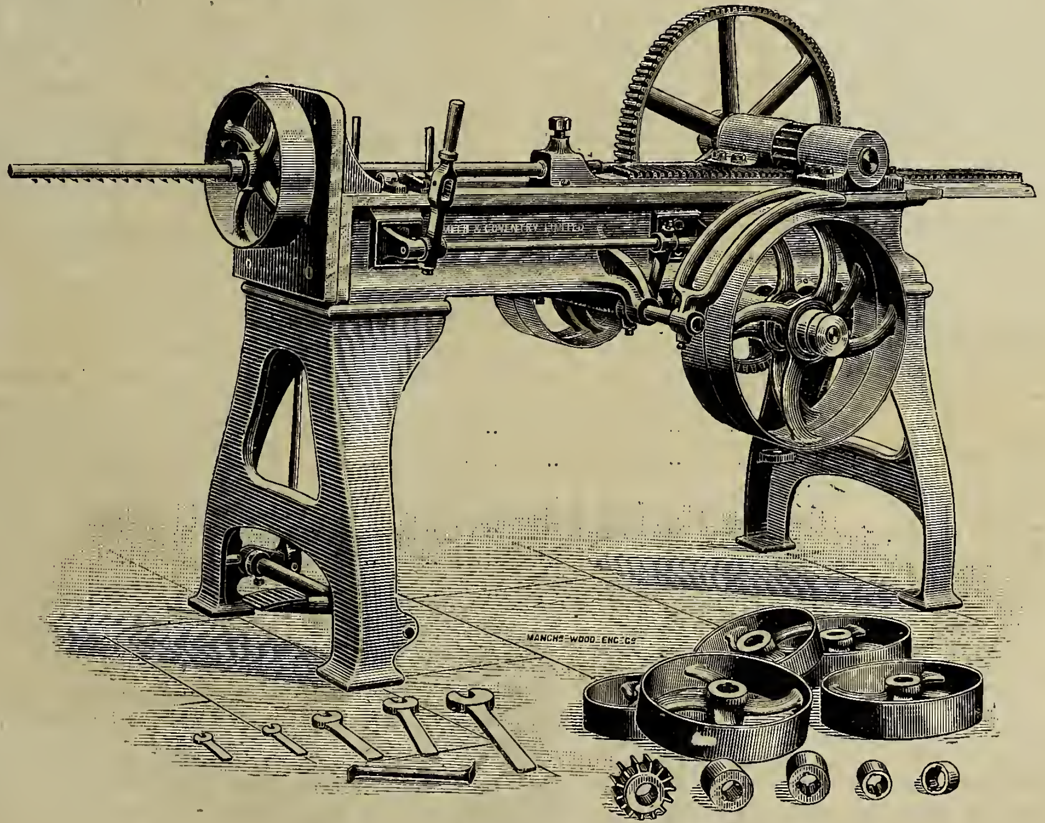


Fig. 1.—Sectional Plan of Rolls.



SMITH AND COVENTRY'S PATENT KEY-SEATER.

The machine is driven by powerful gearing, and the framing is exceptionally strong and massive. The side rolls are adjusted by power, and all the handles for regulating the various adjustments are brought to the back of the machine, so as to leave the space in front entirely free of any obstruction, while the front roll is arranged so that it can be readily lifted out of its bearings when plates are being bent to a complete circle.

GLASGOW EXHIBITION.

(Continued from page 345.)

A notice of the exhibition, from a mechanical point of view, would be incomplete without a reference to the admirable exhibit of engineers' tools displayed by Messrs. Smith and Coventry, of the Gresley Ironworks, Salford.

One of the most interesting machines on their stand is that described in the catalogue as Knowles' patent key-seater, and which is shown in the illustration below. This machine has been designed to cut keyways in wheels, pulleys, &c., which it does with much greater rapidity and accuracy than the old-fashioned method of cutting the keyways with a slotting machine. The wheel or pulley to be cut is threaded on a central spindle, and the slot is cut by drawing what is termed a "quill" or cutter bar through the hole in the boss. The "quill," in fact, consists of a series of cutters, each of which is slightly deeper than the one in front of it, the last cutter measuring, in fact, the final depth of the keyway. By this means every slot is made to a standard width and depth, and perfectly parallel, or to a fixed taper, as may be desired. The work produced is of the highest class, while it would be difficult to conceive of its more rapid execution. By the use of suitable bushes the same cutter bar and cutter can be used for the same size of slot, quite independent of the diameter of the hole. The rack which draws the "quill" traverses in a slide formed in the upper surface of the bed, and is fitted with adjustable stops at each end. At the left-hand end of the bed a headstock is bolted, against which the article to be slotted is placed, and, as it is held in position by a bush fitting the bore, it needs no cramping, and thus effects a considerable saving in time.

The machine is driven from fast and loose pulleys of large diameter, through powerful gearing, the pinion which gears into the rack being made of steel. It is arranged to run back at an accelerated speed, and has a separate set of pulleys for the purpose, the same arrangement of strap guides acting on both sets. The machine is set in motion for cutting by pressing the treadle at the end of the bed; this also puts the stop into gear for bringing the machine to a stand when the slot is cut. By pressing forward the hand-lever shown on the side of the bed the cutter is brought back for the next job, while the strap is also thrown on to the return pulleys and the stop put in gear for bringing the machine to a stand at the end of the stroke.

Another of this firm's machines that attracted considerable attention was their patent bevel wheel-cutting machine, which was exhibited at the Manchester Exhibition, and of which an illustration was given in our issue of May 6th, 1887. The most interesting feature in this machine is the arrangement by which the cutter spindle is made to slide longitudinally through a certain distance each revolution, and thus to make a cut slightly wider than itself. The oscillation of the cutter varies from nothing to that which is necessary to cut the broadest end of the space between the teeth, and thus cuts a taper groove, which is of course required in a bevelled wheel. The device by which this motion is effected is very ingenious.

Pearn's patent "lightning" tapper is another of Messrs. Smith and Coventry's novelties, which struck us as being exceedingly pretty. The appliance is designed for tapping blind holes for studs, and is arranged for attachment to the spindle of a drilling machine. With a blind hole it is rather difficult to arrest the motion of the tap at the right moment, and it is easy to see that if it be allowed to run too deeply there is great risk of the tap being wrenched off. In the appliance under consideration, the shank of the tap practically consists of two portions, united by face-plates held together by the tension of a spiral spring. The tension of this spring, coupled with the friction of the face-plates, is sufficient to drive the tap, but insufficient to wrench it off, so that in the event of the tap being run hard down the two face-plates cease to turn together, and the upper one slips over the lower one without causing any damage. By means of a nut and a graduated screw the tension of the spring can be regulated so as to afford the requisite power for various sizes of taps.

MARINE-ENGINE CRANK AND SCREW SHAFTING.

On page 365 we gave the new rule as recently issued by Lloyd's Committee for the size of crank shafts, &c., of marine engines, and in connection therewith we here append a table for the *crank* and *propeller* shafts of triple-expansion marine engines working at 150lb. gauge pressure per square inch, which we judge will be found useful for immediate reference. The sizes given in the table advance in sixteenths of an inch at a time, each size being that of the next *sixteenth* of an inch division *above* the *net* calculated result, thus allowing a somewhat slight margin over the rule.

It should be noted that although the table has been worked out in accordance with the rule for triple-expansion engines of 150lb. *gauge* pressure, the table will also apply to ordinary compounds or double-expansion engines when working at an *absolute* pressure of 94·787lb. per square inch, and again to the quadruple-expansion engine when the *absolute* pressure is 182·5lb. per square inch.

This follows from the constants given with the rule: Thus, as 18800 is to 165lb. so is 10800 to 94·787lb., and as 18800 is to 165lb. so is 20800 to 182·55lb.; so that we may say that the table will be correct for triple-expansion engines of 150lb. pressure (by gauge), practically so for double-expansion engines of 80lb. *gauge* pressure, and a little in excess for quadruple-expansion engines of 165lb. gauge pressure per square inch.

Whilst we are upon the subject we might just point out that in comparing the two rules given on page 365, on looking closely at them we find that the rule issued by Lloyd's will, when applied to the case of an ordinary compound or double-expansion engine, always give a larger shaft than that found by the Board of Trade rule, *provided* that the ratio of area of the low-pressure cylinder to that of the high-pressure is *greater* than 3·11. This will generally be found to be the case in present practice.

Similarly, with respect to the three-cylinder triple-expansion engine working on *three* cranks, the annexed table will, in every case where the ratio of the area of the low-pressure cylinder to that of the high-pressure is *greater* than 6·47, give a diameter of shaft *greater* than would be necessary to suit the rule of the Board of Trade.

Further, when a quadruple-expansion engine works upon *two* cranks, and where the ratio of low-pressure to high-pressure cylinders is *greater* than 8·, the Lloyd's rule will again give a larger shaft than is necessary for the Board of Trade. This is useful to remember, as it is evident that in nearly every case, as cited above, where the usual proportion of cylinders obtains, a shaft which will pass Lloyd's will be sufficiently strong to pass the Board of Trade.

Intermediate Shafting.—The *diameter* of intermediate or "tunnel" shafting will, in the case of Lloyd's rule, be found to be almost exactly 0·96 (96 per cent) of that of the crank shaft;

TABLE GIVING DIAMETER OF CRANK AND PROPELLER SHAFTS FOR TRIPLE-EXPANSION ENGINES, WORKING AT 150lb. GAUGE PRESSURE PER SQUARE INCH.

(Constructed in accordance with Lloyd's Formula for the same.)

Stroke in inches.	Diameter of Low-pressure Cylinder in Inches.																				
	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
18	$5\frac{1}{4}$	$5\frac{3}{8}$	$5\frac{1}{2}$	$5\frac{5}{8}$	$5\frac{11}{16}$	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
19	$5\frac{3}{8}$	$5\frac{7}{16}$	$5\frac{9}{16}$	$5\frac{11}{16}$	$5\frac{13}{16}$	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
20	$5\frac{7}{16}$	$5\frac{9}{16}$	$5\frac{11}{16}$	$5\frac{13}{16}$	$5\frac{15}{16}$	6	$6\frac{1}{8}$	$6\frac{1}{4}$	$6\frac{3}{8}$	..	..	..	..	..	..	..	..	..	..	..	..
21	$5\frac{1}{2}$	$5\frac{5}{8}$	$5\frac{3}{4}$	$5\frac{7}{8}$	6	$6\frac{1}{8}$	$6\frac{1}{4}$	$6\frac{3}{8}$	$6\frac{7}{16}$	..	..	..	..	..	..	..	..	..	..	..	..
22	$5\frac{5}{8}$	$5\frac{3}{4}$	$5\frac{7}{8}$	6	$6\frac{1}{8}$	$6\frac{1}{4}$	$6\frac{5}{16}$	$6\frac{7}{16}$	$6\frac{9}{16}$	..	..	..	..	..	..	..	..	..	..	..	..
23	$5\frac{11}{16}$	$5\frac{13}{16}$	$5\frac{15}{16}$	$6\frac{1}{16}$	$6\frac{3}{16}$	$6\frac{5}{16}$	$6\frac{7}{16}$	$6\frac{9}{16}$	$6\frac{5}{8}$	..	..	..	..	..	..	..	..	..	..	..	..
24	$5\frac{3}{4}$	$5\frac{7}{8}$	6	$6\frac{3}{16}$	$6\frac{1}{4}$	$6\frac{3}{8}$	$6\frac{1}{2}$	$6\frac{5}{8}$	$6\frac{3}{4}$	$6\frac{7}{8}$	7	$7\frac{1}{8}$	$7\frac{1}{4}$	$7\frac{5}{16}$	..	..	..	..	..	..	..
25	$5\frac{7}{8}$	6	$6\frac{1}{8}$	$6\frac{1}{4}$	$6\frac{3}{8}$	$6\frac{1}{2}$	$6\frac{5}{8}$	$6\frac{3}{4}$	$6\frac{7}{8}$	7	$7\frac{1}{16}$	$7\frac{3}{16}$	$7\frac{5}{16}$	$7\frac{7}{16}$	..	..	..	..	..	..	..
26	$5\frac{15}{16}$	$6\frac{1}{16}$	$6\frac{3}{16}$	$6\frac{5}{16}$	$6\frac{7}{16}$	$6\frac{9}{16}$	$6\frac{11}{16}$	$6\frac{13}{16}$	$6\frac{15}{16}$	$7\frac{1}{16}$	$7\frac{3}{16}$	$7\frac{5}{16}$	$7\frac{7}{16}$	$7\frac{9}{16}$	..	..	..	..	..	..	..
27	6	$6\frac{1}{8}$	$6\frac{1}{4}$	$6\frac{3}{8}$	$6\frac{9}{16}$	$6\frac{11}{16}$	$6\frac{13}{16}$	$6\frac{7}{8}$	7	$7\frac{1}{8}$	$7\frac{1}{4}$	$7\frac{3}{8}$	$7\frac{1}{2}$	$7\frac{5}{8}$	$7\frac{3}{4}$	$7\frac{7}{8}$	8	$8\frac{1}{16}$	..	..	..
28	$6\frac{1}{16}$	$6\frac{3}{16}$	$6\frac{3}{8}$	$6\frac{1}{2}$	$6\frac{5}{8}$	$6\frac{3}{4}$	$6\frac{7}{8}$	7	$7\frac{1}{8}$	$7\frac{1}{4}$	$7\frac{3}{8}$	$7\frac{1}{2}$	$7\frac{5}{8}$	$7\frac{3}{4}$	$7\frac{13}{16}$	$7\frac{15}{16}$	$8\frac{1}{16}$	$8\frac{3}{16}$	$8\frac{5}{16}$	$8\frac{7}{16}$	$8\frac{9}{16}$
29	$6\frac{1}{8}$	$6\frac{5}{16}$	$6\frac{7}{16}$	$6\frac{9}{16}$	$6\frac{11}{16}$	$6\frac{13}{16}$	$6\frac{15}{16}$	$7\frac{1}{16}$	$7\frac{3}{16}$	$7\frac{5}{16}$	$7\frac{7}{16}$	$7\frac{9}{16}$	$7\frac{11}{16}$	$7\frac{13}{16}$	$7\frac{15}{16}$	$8\frac{1}{16}$	$8\frac{3}{16}$	$8\frac{5}{16}$	$8\frac{3}{8}$	$8\frac{1}{2}$	$8\frac{5}{8}$
30	$6\frac{1}{4}$	$6\frac{3}{8}$	$6\frac{1}{2}$	$6\frac{5}{8}$	$6\frac{3}{4}$	$6\frac{7}{8}$	7	$7\frac{1}{8}$	$7\frac{1}{4}$	$7\frac{3}{8}$	$7\frac{1}{2}$	$7\frac{5}{8}$	$7\frac{3}{4}$	$7\frac{7}{8}$	8	$8\frac{1}{8}$	$8\frac{1}{4}$	$8\frac{3}{8}$	$8\frac{1}{2}$	$8\frac{5}{8}$	$8\frac{3}{4}$
31	..	..	..	..	..	$6\frac{15}{16}$	$7\frac{1}{8}$	$7\frac{1}{4}$	$7\frac{3}{8}$	$7\frac{1}{2}$	$7\frac{5}{8}$	$7\frac{3}{4}$	$7\frac{7}{8}$	8	$8\frac{1}{8}$	$8\frac{1}{4}$	$8\frac{3}{8}$	$8\frac{1}{2}$	$8\frac{9}{16}$	$8\frac{11}{16}$	$8\frac{13}{16}$
32	..	..	..	..	..	$7\frac{1}{16}$	$7\frac{3}{16}$	$7\frac{5}{16}$	$7\frac{7}{16}$	$7\frac{9}{16}$	$7\frac{11}{16}$	$7\frac{13}{16}$	$7\frac{15}{16}$	$8\frac{1}{16}$	$8\frac{3}{16}$	$8\frac{5}{16}$	$8\frac{7}{16}$	$8\frac{9}{16}$	$8\frac{11}{16}$	$8\frac{13}{16}$	$8\frac{15}{16}$
33	..	..	..	..	..	$7\frac{1}{8}$	$7\frac{1}{4}$	$7\frac{3}{8}$	$7\frac{1}{2}$	$7\frac{5}{8}$	$7\frac{3}{4}$	$7\frac{7}{8}$	8	$8\frac{1}{8}$	$8\frac{1}{4}$	$8\frac{3}{8}$	$8\frac{1}{2}$	$8\frac{5}{8}$	$8\frac{3}{4}$	$8\frac{7}{8}$	9
34	..	..	..	..	..	..	..	..	..	$7\frac{11}{16}$	$7\frac{7}{8}$	8	$8\frac{1}{8}$	$8\frac{1}{4}$	$8\frac{3}{8}$	$8\frac{1}{2}$	$8\frac{5}{8}$	$8\frac{3}{4}$	$8\frac{7}{8}$	9	$9\frac{1}{8}$
35	..	..	..	..	..	..	..	..	..	$7\frac{13}{16}$	$7\frac{15}{16}$	$8\frac{1}{16}$	$8\frac{3}{16}$	$8\frac{5}{16}$	$8\frac{7}{16}$	$8\frac{9}{16}$	$8\frac{11}{16}$	$8\frac{13}{16}$	$8\frac{15}{16}$	$9\frac{1}{16}$	$9\frac{3}{16}$
36	..	..	..	..	..	..	..	..	..	$7\frac{7}{8}$	8	$8\frac{1}{8}$	$8\frac{1}{4}$	$8\frac{3}{8}$	$8\frac{1}{2}$	$8\frac{5}{8}$	$8\frac{3}{4}$	$8\frac{7}{8}$	9	$9\frac{1}{8}$	$9\frac{1}{4}$
37	..	..	..	..	..	..	..	..	..	..	..	..	..	..	$8\frac{5}{8}$	$8\frac{3}{4}$	$8\frac{7}{8}$	9	$9\frac{1}{8}$	$9\frac{1}{4}$	$9\frac{3}{8}$
38	..	..	..	..	..	..	..	..	..	..	..	..	..	..	$8\frac{11}{16}$	$8\frac{13}{16}$	$8\frac{15}{16}$	$9\frac{1}{16}$	$9\frac{3}{16}$	$9\frac{5}{16}$	$9\frac{7}{16}$
39	..	..	..	..	..	..	..	..	..	..	..	..	..	..	$8\frac{3}{4}$	$8\frac{7}{8}$	9	$9\frac{1}{8}$	$9\frac{1}{4}$	$9\frac{3}{8}$	$9\frac{1}{2}$

and in the case of the rules of the Board of Trade an almost absolute exactness will result if we make the tunnel or intermediate shafting 0·95 (95 per cent) of the necessary diameter of the crank shaft.

The following are Lloyd's rules when simplified to apply to special cases :—

For *crank and propeller shafts* of double-expansion engine working at 80lb. *gauge* pressure—

$$\textit{Least diameter of shaft} \doteq \sqrt[3]{\cdot 0088\,\mathrm{SD}^2}$$

$$\text{or,} \quad = \cdot 20643\,\sqrt[3]{\mathrm{SD}^2}$$

and for other *pressures* the above constants will vary thus :

85lb. the constants will be ·00926 and ·21
90lb. „ „ ·00973 and ·2135
95lb. „ „ ·01019 and ·217
100lb. „ „ ·01065 and ·22

For *the crank and propeller shafts* of triple-expansion engine working at 150lb. *gauge* pressure :

$$\textit{Least diameter of shaft} = \sqrt[3]{\cdot 00878\,\mathrm{SD}^2}$$

$$\text{or,} = \cdot 2063\,\sqrt[3]{\mathrm{SD}^2}$$

and for pressures of—

155lb. the constants are ·00904 and ·2083
160lb. „ „ ·00931 and ·21036
165lb. „ „ ·0096 and ·212343

The rule, when transposed for the purpose of finding the pressure, being—

$$\textit{Boiler pressure} = \frac{d^3\mathrm{C}}{\mathrm{SD}^2} - 15$$

AN ENGINEER'S LIFE AT SEA.—XII.

BY A SEA-GOING ENGINEER.

Ballast Tanks : Stability of Vessel.

Besides circulating and service water, tanks are sometimes provided for water ballast. With cargo in, these are empty, but they are run up in order to give stability to a light ship. There are usually three, the middle, or main ballast tank being the largest. Some regard a full ballast tank as a stiffener or backbone to the steamer, giving it rigidity where weakest, and one captain who held this view, but was unwilling to lessen his cargo, used to load his vessel down to "Plimsoll" in dock, with empty tanks, and when fairly away from the Board of Trade officials have the main ballast tank run up. The consumption of coal would be calculated in a few days to bring the vessel up to its marks again. In running up these tanks, the caps of the air-pipes on deck must be first removed, so as to let out the air. This, though self-evident, is sometimes forgotten, with the result that the tanks will not fill. The removal of the caps is of still more importance in pumping out. Not only will the suction stop the outflow, and hold down the caps so tightly that they cannot afterwards be removed, but as the flat surfaces of the tanks are not calculated to withstand atmospheric pressure, damage may be done. In running up these tanks, and when nearly full, from the air-pipes on deck, water will sometimes spout out several feet into the air. These geyser-like fountains are due to imprisoned air acting as a cushion, and tell of a rise somewhere in the top of the tank, so that the air-pipes are not from the highest part of it. There are usually two pipes, so that whichever way the ship may be listed, the air can escape. Their spouting peculiarity was once put to a novel use. On a certain steamer there were a number of deck passengers. One of them, a gorgeously apparelled Turk, feeling superior to the others, had spread his couch in a retired spot, with a deckhouse behind him and a mast in front of him, but unfortunately with an open air-pipe at his head, and another at his feet. A mischievous "second," who took in the possibilities of the situation, passed down the word to open the already full tank on the sea again.

The result was startling, for as the ship gently rocked on the Mediterranean, the geysers, spouting alternately at his head and feet, caused an undignified and rapid flight of the victim.

Care must be taken to have these tanks either quite full or quite empty when at sea, for a half-full tank is almost as dangerous as a shifting cargo, and will aggravate whatever list there may be on the ship. When in port the tanks are pumped out or run up as regulated by the cargo, and at the discretion of the mate.

As soon as a list appears on a steamer, the engineers must see that the firemen take all their coal from the lowest side. As this makes it necessary to throw the coal from below upward, it will certainly be evaded unless the other bunker doors are shut down securely, and a close watch is kept that they are not opened. As soon as a list sets in everything tends to aggravate it. The cargo, the water in the bilges and in the boilers, the coal in the bunkers, all run to the lower side and keep it down. As steamers are not built to sail on their sides, like sailing ships, they are considerably retarded by a list, and the coal consumption therefore becomes heavier for a given distance. The engines also feel it, and give out a different sound. As engine platforms are usually on the starboard side, a list to port causes the engineer to overhang the crank pits when oiling round, or sends him sliding down the platform to the pumps; while a list to starboard leads to a struggle to reach the engines at all, and frequently will cause hot water to pour on his head or hands while standing in his favourite position. The hanging pumps, too, by their change of position, will probably throw a deep shadow on the places he more particularly wants to see. The iron ladders will either be ascended with unusual ease, or else will have to be clung to and mounted with unusual labour and difficulty, according to their position. However, with the worst list, the steady consumption of coal from the lower side will usually put the ship right in a few days. This method, though slow, is sure, and is much preferable to that reported of a certain captain, who, finding his vessel heeled over by the battering of the waves, had it turned round that the waves might batter it up again, with the result that a clean sweep was made of his boats and deckhouses, leaving his vessel a comparative wreck.

But our engineer will not always be contending with the waves and winds, though he will never be allowed to forget that he is afloat. In long summer days, when off duty, he may lie in his bunk reading or studying, but through the opened port he will hear the ripple of the water along the sides of the ship, and the faint muffled beat of the engines, and will feel the quiver of the straining ship. His hours are marked off by four, six, and eight bells, which remind him that others are watching while he rests. When on deck, every sight and sound tell him he has nothing to do with the shore, and the waves which speed by have for him a strangely familiar look, so that he can sympathise with the old sea captain who declared that he knew every wave in the Atlantic. Even in bad weather an engineer derives a kind of satisfaction, not altogether selfish, from seeing a solitary mate in dripping tarpaulins on the bridge, or the sailors hiding away in safety when a wave breaks over the ship and pours in cataracts from the fo'k'sle head. Then when the spray has cleared away, and he has seen the back of the huge green billow hurrying away to leeward, and watched the water rushing noisily about the deck, he experiences a feeling of contentment. It may be noted in passing, that though many opprobrious adjectives may be applied to the weather, yet through gales and squalls, and through hurricanes in which he cannot face the wind and breathe, he will rarely or never hear the word "storm" used.

By observation and questioning, our engineer will pick up many little scraps of information, which, though not having a direct bearing on his engines, are all part of his sea life. For instance, when he hears the order to "port" the helm (a relic of the days when tillers were used), he will see the sailor put the wheel over to starboard, and know that the helm is going to starboard, and see the ship itself going in the same direction, while an order to "starboard" sends everything to "port." In connection with this he will learn that as soon as the propeller is put to go astern, the ship must be steered *as if* going astern, though it may be at the time forging ahead or even be motionless; and he will see how, by a skilful use of the helm and propeller, a ship can be turned round in a crowded dock. The principle is obvious, for the helm has only to deal with the rush of water past it, and is independent of the action of the ship itself. He will also learn that a sailing ship, being more buoyant than a steamer, rides over waves with dry decks, while the steamer plunges through, and by its attempted resistance sends the spray flying, and whitens the funnel to the top with salt.

As a question of stability, it may be reassuring to the inexperienced to know that the more rapid the roll of a vessel, the more stable it is, and the less chance of its capsizing. When a vessel is top-heavy, it regains its position more slowly, and becomes steadier. A rapid roll, however, tends to strain the ship. With a deck load, the vessel is steadier, but it does not tend to instability in direct proportion to the load, for the heavier the load the deeper the vessel is in the water.

Among these, which we might call deck problems, that of the relative work of the propeller and of the sails holds a foremost place, and the discussion between mates and engineers seems to be ever fresh, and never nearer a solution. An extreme view on one side is that the sails, by heeling the ship over, tend to retard it. An equally extreme but plausible view on the other side is, that in some cases the sails actually drag the propeller, and would drive the ship quicker without it. This, of course, is impossible, for in proportion to the lightening of the load, the speed of the engines is increased. This is readily seen with a vessel aground in a shallow river, as sometimes happens when loading, for with the engines put to go ahead to drive the vessel against the stream their revolutions are much more rapid than usual, being determined by the speed of the current. When put to go astern in these circumstances they revolve slowly. In the former case, the current running in the same direction as the propeller drives the water, and the load on the screw is lightened; in the latter case the propeller tries to drive the water up stream, and moves slowly. This problem suggests another point which frequently leads to considerable argument. It is a widespread error that a vessel steaming against a current will have the speed of its revolution affected. One will maintain that the speed of revolutions will be increased, because, as in the above case, with a vessel aground, the water is running in the direction in which the propeller drives it. Another will maintain that as the propeller has to drive the vessel against the stream its load is therefore increased, and it will revolve more slowly. But whether faster or slower, both will combine against the one who is rash enough to maintain the correct position, which is, that if the friction of the air be neglected it will make no difference whatever in the speed of the revolutions, though a great difference in the speed of the ship. The writer speaks from long and varied experience in this matter.

To be continued.

CORRESPONDENCE.

We do not hold ourselves responsible for the opinions of our Correspondents.

SPECIFICATION FOR A LANCASHIRE BOILER.

To the Editor of "The Practical Engineer."

Sir,—In the "Specification of a Lancashire Boiler," in your issue for the 27th July, there is one item which will appear very faulty to any one accustomed to marine boiler practice. It is specified that the ends are to be joined to the shell by angle irons. No marine engineer would now think of any other method than flanging the end plates both for the shell and furnaces, and I see no reason why a land boiler intended to carry 100lb. pressure should be made in an inferior manner.—Yours, &c. J. D. H.

[There is no objection to the back end plates for Lancashire boiler being flanged for attachment to the shell, instead of being united with an angle ring, and, indeed, this mode of construction is frequently adopted by one leading firm of Lancashire boiler-makers, who have special hydraulic plant by which they are enabled to flange an end plate by one stroke at a single heat. At the front end, however, the angle ring connection is preferable to flanging, on account of the small water space between the furnace tubes and the side of the shell, and the desirability of affording a little elasticity at this part to prevent grooving, and also to afford more space for the fittings.—Ed.]

THE HISTORY OF THE MARINE ENGINE.

To the Editor of "The Practical Engineer."

Sir,—In your issue of August 17th instant I have noticed an essay on the "First Century of the Marine Engine," and as a supplement to that I thought the following account might be interesting to some of your readers.

The idea of propelling vessels by the steam engine appears to have been entertained as soon as that machine had its existence. Savery mentioned the possibility of propelling vessels by steam, but never attempted to carry his project into effect. After the introduction of Newcomen's engine various attempts were made to obtain a revolving motion by which the engine might be applied to machinery in general. Among such attempts was the invention of Mr. Jonathan Hull, of London, who in 1736 took out a patent for the application of the crank to the steam engine, by which addition he proposed "to carry vessels or ships out of or into a harbour, port, or river, against wind or tide, or in a calm." This project was never carried into execution. The application of the crank to the single-acting engine was found a matter of great difficulty, because as the ascending stroke has to be effected by a counterbalance, an immense flywheel is necessary, and it would be absolutely impossible to use a flywheel in a boat. Through want of proper machinery Hull's idea fell to the ground, and, indeed, was so completely forgotten that Mr. Watt actually took out a patent for the application of the crank to the steam engine. The perfection to which the revolving machinery was brought by Mr. Watt and others opened the way to the ready application of steam for purposes of navigation, and sundry trials were made in various parts, especially in Scotland, and the earliest successful one appears to have been made on the Forth and Clyde Inland Navigation, in the year 1801, by Mr. Symington; but this steamboat, although it served to solve the problem, was unfortunately laid aside, on account of the injury sustained by the banks of the Clyde, in consequence of the waves which were raised by the stroke of the paddles.

The next inventor was the ingenious Mr. Oliver Evans, of America, who so early as 1785 had published a description of a mode of driving boats by steam. Untoward circumstances prevented Mr. Evans from carrying his plan into effect until 1804; but he does fully establish his claim to the first contrivance of a *practicable* steamboat.

No experiment of importance after Mr. Symington's in 1801, or Mr. Evans's in 1804, appears to have been tried either in Great Britain or America until the celebrated American engineer, Robert Fulton, constructed a steamboat, which was launched at New York, on October 3rd, 1807, and began to ply between New York and Albany, a distance of 144 miles. In 1812 a boat called the Comet was tried on the Clyde. Shortly afterwards Mr. Theodore Lawrence, of Bristol, constructed a boat, which he tried on the Avon, and, finding it successful, proceeded with her through the canals, to the Thames; but in consequence of some of the bye-laws of the Waterman's Company, he was prevented from using her profitably, and he returned to the Avon.

It appears that the Americans brought steam navigation nearer to a state of perfection than ourselves, not only in their machinery, but in their fitting up and passenger accommodation. The Independence Steam Packet run between New York and Albany, 144 miles, in 11½ hours, and another, called the New Philadelphia, performed the same voyage in 11 hours 50 minutes. They started at six o'clock in the morning, and sailed up the Hudson River, landing passengers in Albany (after stopping at 10 or 12 places) at six o'clock in the evening.

The largest, or one of the largest, steamboats in England about this period was called the United Kingdom Steam Packet, which plied between London and Leith. It was 1,000 tons burthen, and performed the voyage in from 40 to 50 hours. The boat, which measured 148ft. in the keel and 45ft. breadth of beam, was propelled by two engines of 100 H.P. each, constructed by Mr. Napier, of Glasgow.—Yours, &c.

Albert Holt.

Rochdale, August 18th, 1888

EVAPORATIVE TESTS.

To the Editor of "The Practical Engineer."

Sir,—I beg to offer the following observations on evaporative tests, as mentioned by "Sriber" in your issue of August 3rd. By repeated experiments Regnault found that to raise one pound weight of water from the temperature of 32° Fah. to 212°, or the boiling point, under atmospheric pressure a rise of 180°, and then to convert it into one pound weight of steam at that (212°) temperature, required 1146·6 units of heat, or what is equivalent to as much heat as would raise the temperature of 1146·6lb. of water 1° Fah.; and since the temperature remained the same (212°) during vaporisation, heat equivalent to 1146·6 − 180 units, or 966·6°, must have been absorbed in the steam generated at boiling point without raising its temperature, in fact, must have become latent, as it is technically called.

Again, on the temperature of a pound of water being raised from 32° Fah. to 302° Fah., or the boiling point under 70lb. per square inch absolute pressure, being a rise of 270°, and then converted into one pound of steam at that temperature (302°) and pressure of 70lb. per square inch, 1174·07 units of heat were required.

	Temperature.	Heat units.
Therefore	302°	1174·07
	212°	1146·60
	90	27·47

$$\frac{27{\cdot}47}{\text{And } 90{\cdot}00} = 0{\cdot}305 \text{ units of heat per } 1^\circ \text{ of temp.}$$

Whence we see after the water is vaporised ·305 of a unit of heat only is required to raise the temperature of the steam one degree (which ·305 may, of course, be regarded as the specific heat of steam).

It is found that this co-efficient 0·305 is constant for all practicable pressures and temperatures. We therefore see that the increase of the number of heat units in the steam for a long range of temperature is proportional to the increase of temperature. We may now develop formula showing their connection.

Let A be any constant number the value of which we do not yet know.

T be any given temperature of the steam.

H be the number of corresponding heat units.

Then we may assume, as we see from above, that $(A + {\cdot}305T)$ may be supposed to equal H, and therefore $A = H - {\cdot}305T$; and when $T = 212°$, we know $H = 1146{\cdot}6$. Therefore $A = 1146{\cdot}6 + {\cdot}305 \times 212 = 1081{\cdot}94$, say in round numbers 1082. Then $1082 + {\cdot}305T = H$, gives us the number of heat units in steam at any temperature and corresponding pressure.

If it be now required from a given weight of water evaporated under a given pressure and temperature (T) to determine the weight of water that the same amount of heat would evaporate under atmospheric pressure at temperature 212°, we will call the weight of water evaporated at temperature (T) w; and the weight of water evaporated at temperature 212°, by the same amount of heat W; then we have

$$\frac{Hw}{1146{\cdot}6} = W, \text{ or } \frac{1082 + {\cdot}302T}{1146{\cdot}6} w = W$$

The weight W obtained above is, as we see, on the supposition that the feed water in each case is supplied to the boilers at temperature 32°.

When the feed water is at any higher temperature, say t°, the units of heat required by one pound of water to raise its temperature from t° and vaporise it at temperature T° will, of course, be $1082 - (t - 32) + {\cdot}305T$, or $1114 - t^\circ + {\cdot}305T^\circ$; while the units of heat required to vaporise one pound of water already at temperature 212°, the temperature remaining the same (212°) during the process, is as per rule, $1114 - 212 + {\cdot}305 \times 212 = 966{\cdot}6$, or merely the latent heat. Therefore the quantity of heat required to raise one pound of feed water from temperature t° to T° and vaporise it at that (T) temperature, is to the quantity of heat required to vaporise one pound of water already at temperature 212°, its temperature remaining constant (212°) during the process, as $(1114 - t + {\cdot}305T)$ to $966{\cdot}6$, or $\frac{1114 - t + {\cdot}305T}{966{\cdot}6} \times w = W$.

Yours truly, W. A.

P.S.—Rankine calls the above 0·305, for simplicity, ·3 merely.

PUMPING WATER.

To the Editor of "The Practical Engineer."

Sir,—In order to demonstrate to your correspondent, "Tangye Pump," the cause of his difficulty, and to suggest a remedy, it will be necessary, as he does not state, to assume that the pump has a single-acting ram of 6¾in. diameter, and say 12in. stroke. The suction pipe being 4in. diameter has an area of 12·56in., and the area of the ram is 35·78in. The water will therefore have to travel 2·848 times quicker in the pipes than the ram travels during its lift, At thirty strokes per minute the ram moves at the rate of 1ft. per second, and the water in the suction pipes 2·848ft. per second. If the ram makes sixty strokes per minute, it moves 2ft. per second, and the water in the pipes would have to travel 5·696ft. per second to fill the pump barrel whilst the ram rises, and quicker in proportion as the stroke of the ram exceeds 12in.

In lifting water by suction 12ft. high it is equivalent to giving a head of 22ft., and a 4in. pipe 150 yards, with that head, will deliver 190 gallons per minute, if the pipes are free from rust or sediment, and without bends, and the flow continuous. This delivery is equal to a motion in the pipes of 5·825ft. per second, and is the greatest that can be got. In pumping, if the water be hot, the pipes coated with rust, or quick bends in them, not near this velocity can be got, even if the flow were continuous.

It may therefore be assumed that in actual conditions of work the velocity of the water in the pipes, even with a continuous flow, would be insufficient to fill the pump barrel during the rise of the ram at sixty strokes per minute. But with a single-acting ram the motion of the water in the pipes is stopped each alternate half-second, and the pipe contains 2,445lb. of water. The whole of this weight has to be set in motion each alternate half-second, and then only for one half-second.

According to the laws of "inertia," and of "falling bodies," it is impossible for the water to attain the velocity required.

The remedy is a double-acting ram, or two single-acting ones working alternately at thirty strokes per minute; or, if the present ram be worked sixty strokes per minute, larger pipes that will deliver about double the quantity, say of from 5in. to 6in. diameter.—Yours, &c.

Oldham, August 25th, 1888. John Ashton.

QUERIES AND REPLIES.

Horse-power Engineer.—Will you kindly inform me what is the nominal horse power of my engine? The cylinder is 9¼in. diameter and the piston is 1ft. 6in., and the engine makes 88 revolutions per minute. The boiler pressure shows 60lb. by the gauge. There is no cut-off, and the engine drives all the load it can possibly struggle with. I have no means of applying an indicator.

Answer.—The term nominal horse power is very misleading, and it is better to avoid its use as far as possible. Assuming the steam to be carried on the piston throughout the whole length of the stroke, and that the pressure in the cylinder is the same as that in the boiler, the power of the engine by calculation would be a little over 5 I.H.P. As, however, the pressure in the cylinder will be lower than that in the boiler, the horse power of the engine will be less than this. The exact power cannot, of course, be ascertained without indicating.—Ed.

Discharge of Pump.—I shall be obliged if you will give me a plain, practical rule for the quantity of water a pump will lift or force, the diameter of pump being given, also length of stroke, and number of strokes per minute.—Durrham.

Answer.—If D = Diameter of plunger in inches,
L = Length of stroke in feet,
N = Number of strokes per minute,
Q = Cubic feet discharged per minute,
G = Gallons discharged per minute,

Then for a double-acting pump

$$Q = {\cdot}0054 \times D^2 \times L \times N$$
$$G = {\cdot}034 \times D^2 \times L \times N.$$

If the pump be single-acting, the above result would, of course, require to be divided by two. The above formula is based on the assumption that the pump is theoretically perfect. It is usual, however, to increase the area of the plunger by about one-fourth, so as to allow for leakage, friction, &c.—Ed.

Self-acting Damper.—Can any reader furnish me with the address of Barratt's patent self-acting damper for steam boilers?—Stoker.

Answer.—We believe the contrivance referred to is made by Mr. Thomas Irving, 17, Gracechurch Street, London, E.C.—Ed.

Hot v. Cold Air for Boiler Furnaces.—Will some reader of *The Practical Engineer* kindly answer me the following questions: First, will hot air answer as well as cold air for a boiler furnace? Second, will hot air answer as well as cold air for smoke burning? Third, which will burn the least fuel?—S. B., Engine-tenter.

Answer.—In reply to your queries, we should say hot air would be better every way than cold, both on the score of smoke burning and economy, but the question arises how is the air to be heated? There are, of course, several ways in which it can be done, but some are much more satisfactory than others. Holden's assisted draught furnace, of which a notice and illustration appeared in our issue of the 17th instant, shows a method of accomplishing the object which is claimed to be both effective and economical.—Ed.

Royle's Steam Trap.—Will some generous reader of your valuable paper kindly enlighten me as to the principle and mode of construction of Royle's patent syphon steam trap? I have one which works very satisfactorily, but I don't thoroughly understand the principle.—Novice.

Answer.—You will find an illustration, accompanied with an explanation of the same, in our issue for August 19th, 1887, page 345.—Ed.

Locomotive Tube Plate.—Can any reader explain to me the reason of a locomotive tube plate cracking through the top row of tube holes at the smokebox end, and the plate bulging in ⅜in. after it has been at work. The plate is of steel, ¾in. thick, and the barrel is 3ft. 9in. diameter.—Locomotive.

Answer.—The defect you speak of is not one of those usually found in the class of tube plate you mention. It will be difficult to explain the cause without seeing the actual plate, and mode of staying, &c. I should think, however, the defect has been caused through the tube plate having been badly handled in flanging, probably having been buckled and left with some parts in tension, although it might have appeared straight and flat. Sometimes the tube holes are punched and then rimered out. This is a barbarous method, but it is done, and might just lead to the defect you describe.—Chalkline.

Average Temperature.—Could you or any of your readers give me an average temperature of the weather from June 25th, 1886, to June 25th, 1887, and from June 25th, 1887, to the same date in 1888? You will see what I mean when I inform you that we have burnt over 200 tons of slack more this year than last, and we have no extra heating to do—less, if anything, than the year before.—Engineer.

Sun-copying Drawings.—Can any reader oblige me with a recipe for sun-copying tracings, black lines on a white ground, similar to copies I have seen?—J. T.

Perrett's Patent Furnace.—Can any reader furnish me with the address of Perrett's patent furnace for burning small coal or "breeze?"—Stoker.

Fixing Propeller Shaft.—I shall be greatly obliged if you or any reader of your paper will inform me of the best method or the one mostly used on board ship to retain the propeller shaft.—H. B. C.

Helical Wheels.—Can any of my fellow-readers inform me of the best mode of setting out the teeth of a pair of bevel helical wheels, the larger wheel to be 34·8in. diameter, with 6in. face and 73 teeth, 1½in. pitch, and the smaller one or pinion 18·14in. diameter, with 6in. face and 38 teeth 1½in. pitch? Also a plain spur wheel 77·98in. diameter, with 140 teeth, 1¾in. pitch, to work in a pinion 40·1in. diameter, with 72 teeth. Any information with regard to making the patterns would oblige.—J. W. J.

Navy Electrician.—Could you or any of your numerous readers give me any information as to the requirements of electricians in the Navy, and how one who has a good knowledge, both practical and theoretical, of electric lighting may become one?—T. H.

Cement for Brass.—Will you or some of your numerous readers kindly give me a recipe for or the name of the best manufactured cement for brass? I want to attach brass rings to the outside of a brass cylinder by means of cement.—Marine.

Starting Gear.—A sketch and description of "Brown's steam and hydraulic starting gear" would be appreciated by S. B.

Cast-iron Gutters.—Can any reader tell me the technical name of the cast-iron gutters that connect the down pipe from the roof to the gutters along the pavement of a road?—H. L. Crate.

Portland Cement.—I should be glad if some reader would tell me the strength of Portland cement for beams, and also for fireproof floors. I should also be glad of a section of a fireproof floor capable of bearing a load of 3cwt. per foot the floor having a span of 20ft. clear.—H. L. Crate.

Lift for Pump Clacks.—Will you oblige by giving the required lift for pump clacks or valves, and how to calculate the same in plain figures? Ex. 1.—For a 5in. ram pump, 2ft. 6in. stroke, running 30 revs. per min. Ex. 2.—For a 9½in. ram pump, 1ft. 9in. stroke, running 26 revs. per min.—Engine Attendant.

Finishing and Colouring Drawings.—In reference to the reply to a query on this subject in last week's issue, a correspondent writes to say he has found that if a weak solution—say one per cent.—of bichromate of potash be used for mixing Indian ink, the lines will, after an hour or two's exposure, become insoluble.—Ed.

TO CORRESPONDENTS.

Land Surveying.—In reply to "H. E. Lütte," we have still a difficulty in understanding your question. We presume, however, you want a book on land surveying, if so, the one by T. Baker will probably best suit your purpose. It contains full elementary instructions on the subject. The price is two shillings, and it may be obtained through this office on receipt of stamps to that amount.

W. William.—Your letter of the 25th received. We are always glad to render assistance, and shall be pleased if any advice we can at any time give proves of service.

MISCELLANEA.

A Fast Voyage from the Cape.—The Union Company's steamer Tartar, which arrived at Plymouth on Saturday from Capetown, made the passage in 17 days and six hours, the fastest on record.

The End of the Great Eastern.—The steamship Great Eastern, which has passed through so many vicissitudes since her launch 30 years ago, was successfully beached near New Ferry, on the Cheshire shore of the Mersey, on Saturday last, with a view to being broken up.

Technological Examinations.—The first prize in honours' on the subject of Mechanical Engineering awarded by the City and Guilds of London Institute in the Technological Examinations has this year been awarded to Mr. Wilfrid J. Lineham, of Newcastle-on-Tyne.

Honours for an Engineer.—We notice that Mr. Guildford L. Molesworth has been created a Knight Commander of the Indian Empire. Mr. Molesworth has been for many years an official consulting engineer of the Indian State railways, but he is better known to the world as the compiler of that excellent work, "Molesworth's Pocket Book of Engineering Formulæ."

The Cutlers' Company.—At a meeting of the Cutlers Company last week Mr. Samuel Earnshaw Howell, the Senior Warden, was elected Master Cutler, in succession to Mr. James Dixop, whose year of office expires on September 6th. The Master Cutler-elect will be installed on that day, and in the evening he will preside at the Cutlers' Feast.

Lightning Conductors.—The organising committees of Sections A and G of the British Association have arranged a joint discussion on "Lightning Conductors" to be held at the Bath meeting in September. Mr. W. H. Preece, F.R.S., the president of Section G, will open the discussion, and Professor Oliver J. Lodge, F.R.S., will defend the position he took up this year before the Society of Arts.

The Steel Company of Scotland.—At a meeting of the directors of the Steel Company of Scotland, on Tuesday, it was agreed to recommend (subject to audit) the payment of a dividend at the rate of 5 per cent. per annum, free of income-tax, after writing off for depreciation £15,000, adding £2,500 to the reserve fund, and carrying forward about £1,400 to next year. The dividend for last year was 3½ per cent., with £1,100 forward.

The Forth Bridge.—At the half-yearly meeting of the Forth Bridge Railway Company, held in Edinburgh, the Marquis of Tweeddale, who presided, stated that the estimate which was made some months ago as to the work which was required to be done in the course of each month in order that the bridge might be completed by October, 1889, had proved strictly accurate. They had now every reason to believe that the bridge would be completed not later than the date referred to. The lines connected with the bridge on the Edinburgh side and on the north side were making very satisfactory progress, and they were confident that they would be completed simultaneously with the bridge itself.

The Maxim Gun.—A report has been presented to the War Office upon important experiments recently made with the Maxim gun, at 600 and 800 yards, in comparison with fire from Martini-Henry rifles. At 600 yards, 15 men, all first or second class shots, fired 10 volleys, and made 52 per cent of hits in 3min. 46sec.; while the Maxim, firing the same number of rounds at the same targets, made 81·56 per cent of hits in 2min. 36sec. At 800 yards the results were—Fifteen Martini-Henrys, 40·66 per cent of hits in 3min. 40secs.; Maxim, 80 per cent in 1min. 30sec. The targets were arranged so that the volleys fired by the men were directed alternately a quarter right and a quarter left, the interval between the targets being 12 yards; the Maxim fired 15 shots alternately on each target.

Proposed Ship Canal.—The project of a maritime ship canal to connect Bristol with the English Channel is being revived, and it is understood that a syndicate is in course of formation with a view to its promotion. This plan has long been favoured by many of those interested in mercantile and commercial pursuits, and the feasibility of the suggested undertaking has, it is understood, been favourably reported on by eminent engineers. It is proposed to construct a ship canal from Bridgwater Bay, commencing at Stolford, on the Somerset coast, via Taunton, and terminating at Seaton, on the South Devon coast. The length of the proposed canal will be 45 miles, and it is proposed to make it of sufficient capacity for vessels of the largest tonnage. The great recommendation of this proposed connection of the Bristol and English Channels is that it will effect a saving of nearly 300 miles, its main object being to get rid of the necessity for ships plying from the Bristol Channel to the English Channel ports, the Continent, and the Baltic, &c., being compelled, as they are now, to go round the Land's End, the Lizard, and past the Cornish and North Devon coast. It is also suggested that Stolford and Seaton, at either end of the proposed canal, could be converted into efficient harbours of refuge. The cost of construction is at present roughly estimated at £70,000 per mile.

SELECTED PATENTS.

APPLICATIONS FOR LETTERS PATENT.

May 22nd.

7552a. Sewing Machines &c., B. Willcox, London. (The Willcox and Gibbs Sewing Machine Co., United States.)

August 17th.

11859 Aluminium, F. W. Gerhard and T. Bantock, Wolverhampton.
11860 Dolominium, F. W. Gerhard and T. Bantock, Wolverhampton.
11861 Calcium, F. W. Gerhard and T. Bantock, Wolverhampton.
11862 Forewarning Fog Signal, A. Wilcock, Dewsbury.
11864 Lubricators, R. Marchant and W. Marchant, Manchester.
11871 Railway Fog-signalling Apparatus, W. P. Mara, London.
11877 Railway Trains, W. Birch, Manchester.
11883 Sewing Machines, F. H. O. Jerram, London.
11892 Apparatus for Signalling, J. Beech, Bradford, Yorkshire.
11893 Taps or Cocks, J. Newton, Longport.
11896 Instruments, M. Piper, Oldham.
11897 Electrical Indicators, O. B. Shallenberger, United States, or W. P. Thompson, as a communication from G. Westinghouse.—[Complete Specification.]
11898 Electrical Indicators, O. B. Shallenberger, United States, or W. P. Thompson. as a communication from G. Westinghouse.—[Complete Specification.]
11899 Automatic Fire Alarm and Indicator, N. Knowles, London.
11909 Portland Cement, J. W. T. Stephens and R. Clark, London.—[Complete Specification.]
11917 Electric Energy, J. G. Lorrain, London.
11920 Motive Power, H. H. Lake, London. (H. D. Haverkamp, Holland.)
11924 Construction of Railway Carriages, J. O. Tournicr, London.
11925 Electrical Switches, H. W. Edlin, London.

August 18th.

11929 Electrical Indicators, G. Binswanger, London.
11936 Carriage Axles, J. Grice, Birmingham.
11937 Apparatus for Driving Dynamos, F. C. Lynde, Manchester.
11938 Jacks or Gearing, G. Haworth and S. Fallows, Halifax.
11939 Non-magnetic Metallic Alloy, H. Ostermann and A. Prip, London.—[Complete Specification.]
11943 Steam Engines, E. K. Dutton, Manchester. (The American Engine Co., United States.)—[Complete Specification.]
11957 Sand Moulding Machines, B. Schuchardt and H. Schutte, Birmingham.—[Complete Specification.]
11958 Steam Boilers, H. Gourlay, London.
11963 Electric Rail or Tramway Systems, M. H. Smith, Middlesex.
11965 Anti-induction Electric Apparatus, J. Cerpaux, P. Borre, and L. Maertens, London.
11969 Rotative Furnaces or Kilns, &c., F. Siemens, London.—[Complete Specification.]
11978 Moulds, A. B. Cole, London. (C. H. Wilder, United States.)
11983 Steam Boiler, J. A. Eno, London.—[Complete Specification.]

August 20th.

11987 Wire-drawing Machinery, G. Christie and A. Dunlop, Glasgow.
12016 Stuffing Boxes, H. Gourlay, London.
12022 Metal Pipes, &c., F. E. Elmore and A. S. Elmore, Cockermouth.

August 21st.

12029 Piston Packing Ring, J. Turnbull, jun., Glasgow.—[Complete Specification.]
12031 Valves and Taps, F. T. Schmidt, Keighley.
12038 Sheet Metal Structures, W. Orr and P. S. Brown, Glasgow.
12046 Nut Locks, H. Cul'abine, Sheffield.
12049 Rotary Railroad Track Crossing, J. S. Toppan, G. B. Marsh, and M. M. S. Marsh, London.
12053 Metallic Alloy, T. Slater, London.
12054 Telegraphic and Telephonic Circuits, E. Liehert and S. A. Rosenthal, London.
12060 Steam Generators, G. Durr, Liverpool.—[Complete Specification.]
12063 Electrical Type-writers, A. J. Boult, Middlesex. (J. F. McLaughlin United States.—[Complete Specification.]
12072 Valve Cocks, A. P. Howes, London,—[Complete Specification.]
12075 Steam Generators and Water Heaters, J. W. von Pittler, London.
12076 Steam Engines, J. Richardson and J. R. Richardson, London.
12083 Screw Propellers, C. A. V. de Vismes, London.—[Complete Specification.

August 22nd.

12097 Cleaning Tin and Terne Plates, A. J. Maskrey, Bristol.
12098 Improved Screw-brass, E. C. Taylor, Coniston.
12101 Tin, Terne, &c., J. Jenkins and B. H. Thomas, Bristol.
12104 Valves, R. W. Mewes, Newcastle-on-Tyne.
12112 Apparatus for Extracting Coke, T. Smith, London.
12114 Metal Sheets, G. C. Fricker, London.
12115 Rope Grip, R. S. Williamson, Middlesex.
12121 Calculating Machines, P. M. Justice, Middlesex.—[Complete Specification.]
12124 Oscillating Pumps, J. A. Batley, London. (A. Vermersch, France.)
12125 Lubricating Apparatus, J. A. Batley, London. (A. Vermersch, France.)
12127 Electric Motors, J. Feaveryear, London.
12129 Automatic Electric Signalling, J. L. E. Daniel, London.
12136 Helicoidal Motor Wheels, J. Farcot, London.

August 23rd.

12146 Sight-feed Lubricator, G. M. Marchant, Halifax.
12149 Electric Battery, J. Hargreaves and J. C. Sewell, Liverpool.
12150 Pulverising Mineral Fuel, W. P. Thompson, Liverpool.—[Complete Specification.]
12151 Steam Engines, L. Langlois, Liverpool.
12158 Working Railways by Electricity, C. E. Spagnoletti, London.
12159 Machine Vices, A. T. Mallard, London.
12160 Ships' Propellers, W. Holder, Sheffield.
12161 Screwing and Turning Bolts, H. C. Trenery, Sheffield.
12166 Steam Boilers, E. Edwards, London.
12169 Automatic Safety Lamps, C. W. Stevens and G. Elliston, London.—[Complete Specification,]
12176 Miners' Benzine Safety Lamps, C. Wolf and H. Friemann, London.—[Complete Specification.]
12177 Double-action Ball or Float Valve or Cock, J. T. Garratt, London.
12182 Apparatus for Drilling Rocks, R. Stephens and W. C. Stephens, London.
12183 Water and Steam Heating Apparatus, E. Peak, London.
12187 Valve Motion, A. Pietsch, London.
12188 Economising Fuel, T. Cain, London.

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Vol. I. (bound), containing Nos. 1 to 44 inclusive, from March to December, 1887, price 6s. 6d., can still be obtained by order from any Newsagent, or will be forwarded, carriage paid, from either of our offices on receipt of the amount by postal order or stamps.

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EDITORIAL NOTICES.

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Contributors are requested to write on one side only of the paper. Sketches should be sent on separate sheets.

TO ADVERTISERS.

Advertisements intended for insertion in the current issue should reach us on Wednesday morning at the latest.

THE
PRACTICAL ENGINEER.
SEPTEMBER 7TH, 1888.

COMPOUND LOCOMOTIVES.

ALTHOUGH it is only within the last few years that we have heard anything explicit regarding this style of locomotive, still it is by no means new. The honour of first proposing to apply the compound system to locomotives, we believe, rests with a Mr. John Nicholson, who, while he was a driver on what was then known as the Eastern Counties Railway (now the Great Eastern), in 1850, brought his arrangement under the notice of Mr. Samuel, the locomotive superintendent, who was so far satisfied with it that he had two locomotives (a passenger and goods) either built or converted to Nicholson's arrangement, and running for some time; but unfortunately we have no records of their performances from an economical point of view, nor is there any reason to be found for their being discontinued.

In this arrangement, known as the continuous expansion compound system, there were two cylinders employed, one high-pressure and one low-pressure, working at right angles on the same axle. Steam was admitted to the smaller cylinder, and cut off again, either at half-stroke or some point less than half-stroke, as the work in hand rendered necessary. After reaching half-stroke, the piston, by its progressive movement, uncovered a port in the cylinder side leading to the steam chest of the larger cylinder, the piston of which was then at the end of its stroke, and about to return. By expansion the steam now moved both pistons until that in the smaller cylinder approached the end of its stroke, when a gridiron slide or some such arrangement closed the passage to the large cylinder, and immediately afterwards the exhaust from the small cylinder commenced, and a supply for the other end was received. The steam in the large cylinder meanwhile continued to move the piston of that cylinder to the end of its stroke, and then exhausted into the atmosphere. By this time the piston of the small cylinder had reached half-stroke in the opposite direction, and the port in the cylinder side was again uncovered to supply steam to the large cylinder, when the same operation was then gone through for the opposite end.

One of the points aimed at by Mr. Nicholson in this arrangement was, while obtaining the greatest amount of useful work of the steam by expansion, to have the exhaust, or some portion of it at least, of such a pressure as would maintain an exciting effect on the fire, as in the simple engine. This, it will be noticed, he obtains from the exhaust from the small cylinder, which, supposing the cylinder areas as 1 to 2, and steam being cut off at half-stroke, has only undergone an expansion of four times, while that of the large cylinder has been expanded eight times. These, then, are the leading features of the first system of compounding applied to locomotives, and although in the case of locomotives it has now no existence, it is still being applied regularly by Messrs. Stewart, Blackwall, for marine purposes.

From the time of Nicholson's arrangement being applied no more was heard of in this direction until 1866, when M. Jules Morandierré designed a locomotive with eight wheels, coupled in independent groups of four. The hind group was driven by a single inside cylinder (high-pressure) turning the leading axle of the group, and exhausting into two outside cylinders (low-pressure) actuating the rear axle of the leading group of wheels. This system was never put into practice, but it is worthy of notice, as to a certain extent it seems to foreshadow the engine described on page 220 of the present volume, that of Mr. Webb. A comparison of the two, however, will show that this design of M. Morandierré's does not possess the same facility of starting seen in Mr. Webb's engine. It must not be supposed from what has just been said that it was from this design Mr. Webb derived the idea wrought out in his own engines. As a matter of fact, Mr. Webb has stated that it was while looking at one of Mr. Crampton's rather peculiar designs that the idea suggested itself.

To continue in correct order, however, the next we hear of compound locomotives is in 1876. In that year M. Anatole Mallet, who it seems had been experimenting for some time previous to this with a system of compounding, generally known as Mallet's system, obtained permission to apply it to three locomotives on the Bayonne and Biarritz Railway. These proved themselves sufficiently economical to induce the construction of others, both for that railway and other railways in France, Spain, Germany, and Russia. In his original engines, M. Mallet used two outside cylinders, one high-pressure and one low-pressure, coupled at right angles to the same axles, their dimensions being 9·45in. and 15·75in. in diameter, and 17·72in. stroke.

In connection with these engines, M. Mallet used a special valve for admitting steam to the large cylinder from the boiler when required for starting, or for some extraordinary effort requiring the same. This valve also allowed the exhaust from the small cylinder to pass into the atmosphere. For the purpose of equalising the work done in the two cylinders, when working non-compound, M. Mallet, in his later engines, used, in connection with the valve just mentioned, a reducing valve which only allowed sufficient steam to enter the large cylinder for that effect. The reducing valve was not so in the three engines first set to work.

He also proposed a tandem arrangement of four cylinders, and his latest is a four-cylinder arrangement somewhat after the Fairlie pattern, without the double-ended boiler. In this arrangement two high-pressure cylinders are coupled at right angles to the trailing axle of the rear bogie, and coupling rods led to the leading wheels. The two low-pressure cylinders are also coupled at right angles, and actuate the trailing axle of the leading bogie, and coupling rods led to the leading wheels.

On the Continent the Mallet system has come into rather extended use, being at work, as before stated, in France, Spain, Germany, and Russia. In Russia, MM. Borodin and Levy have made numerous elaborate experiments to determine the efficiency of the compound system, the average of these showing a saving of from 10 to 20 per cent. The Mallet system was introduced into Prussia by Herr Von Borries, in 1880. In his arrangement there is no provision for working non-compound; in fact, the arrangement is the same as that used by Mr. Worsdell on the North-Eastern Railway.

The system adopted by Mr. Webb on the London and North-Western Railway, as well as that of Mr. Worsdell, has been described in these columns; but it might be stated that as long ago as 1878 Mr. Webb experimented with a locomotive converted on the Mallet system, and it was from points noted by him in the working of this engine that he was led to the construction of his now well-known three-cylinder arrangement. The first engine on this system was put to work in 1882; Mr. Worsdell introduced the Mallet system in 1885.

THE MANCHESTER SHIP CANAL.

THE courage and determination which characterised the conduct of the promoters of the Manchester Ship Canal in the first instance have been admirably supplemented by the vigour since displayed in the prosecution of the work, and an indication of the energy with which the enterprise is being pushed forward was afforded by figures given by Lord Egerton, the chairman of the company, at the general meeting of the shareholders, held at Manchester on Wednesday, the 29th ultimo. Referring to the present state of the works, Lord Egerton said the excavation was everywhere being carried on in such a manner as to justify them in saying that there was not likely to be any great difficulties with regard to the soil which would prevent the canal being completed within the period contemplated. The Bridgewater Canal, which was purchased by the shareholders, and forms part of the present undertaking, has, it appears, realised £60,000 profit during the year, in addition to the sum of £5,000 which had been carried to the reserve fund. The number of men and boys at present engaged in the construction of the canal amounts to 8,568, in addition to the 3,000 employed in connection with the Bridgewater undertaking, making altogether an army of nearly 12,000 workers. This army of labourers is further reinforced by the assistance of 161 horses, 98 locomotives, 3,221 wagons, 51 steam navvies, 49 steam cranes, and 104 pumping and other engines.

REVIVAL OF THE SHIPPING INDUSTRY.

AN extraordinary amount of activity has been developed within the last few weeks in the shipping industry, and the Liverpool correspondent of a contemporary writes that there has been quite a revolution in freights by steamers and sailing ships, and that notwithstanding the great increase that has taken place the rates are still going up. All round, shipping, it is said, has not been in so good a state for many years past. Steamers particularly are in great demand, and owners are now holding back in the hope of even better rates. Black Sea freights have risen within the past few weeks over 25 per cent, whilst the grain rates from San Francisco show enormous development. Indeed the increase in the latter is almost phenomenal, something like 100 per cent since the early part of the year, and shipowners are holding out for more. For Baltic ports the rise has been nearly, if not fully, 50 per cent, whilst the cotton freights have gone up very much. The above freights have improved time charters very greatly, so much so that steamers which could have been got for about 8s. 6d. to 9s. per ton a few weeks ago are now refusing 13s., and asking 14s. and 15s. Altogether the healthy state of the shipping trade is not only most encouraging, but has developed in a remarkably short time, and is still showing further signs of improvement.

MATERIALS OF ENGINEERING.—V.

WROUGHT IRON.

FOR the purposes of the engineer, the principal forms into which malleable iron is rolled consist of plates, sheets, bars (both round and square), flats, angles, tees, channels, and those forms used chiefly in special classes of work, as in shipbuilding and some minor manufactures.

There is, I think, quite as great a range between the higher and the lower qualities of wrought iron as there is between the qualities of cast iron. Hence the use of manufacturer's brands by which, in a rough fashion, these qualities are distinguishable—only rough or approximate in the majority of cases, because the similar brands of different houses may, and often do, indicate irons having different qualities. In specifications for work of first-class excellence, therefore, it is necessary and customary to name three or four houses of whom an iron of a certain brand must be purchased, the iron in such cases of any given brand being known to be within reasonable limits of a certain quality. But, besides this, strips are usually cut off and tested for tensile strength, elongation, and bending.

There are so many brands, that it is impossible to note even those of the leading firms. Bridge, ship, and girder plates, which are the commonest, are usually branded with a crown, and with the manufacturer's name or the initials of the house, such as "Abbott" *crown*, "Butterley" *crown*. Superior qualities range as "Butterley B," "Butterley BB," "Butterley BBB," these being classed as "boiler quality." Fox, Head, and Co.'s brands of boiler plates are "F H & CO" "Best boiler," "Best best boiler," "Best best best boiler." The very best brands of Yorkshire iron are of one quality only. Thus "Lowmoor" is the only brand of that famous company. So again, Farnley brand is "FI CO LM."

Bowling is "BOWLING" simply. The products of the Yorkshire forges are exceptionally good, partly because the ore and fuel are of superior qualities, partly because the puddling process is of a very thorough character, so much as 30 cwt of fuel being used per ton of bars produced.

The sizes of plates, bars, angles, and tees are subject to limitation, so that when made above certain sizes and weights extra prices are charged. But some of the best houses give no limiting dimensions or weights, being prepared to supply large plates, &c., at ordinary quotations, or at a trifling advance on standard prices, provided, of course, that the sizes and weights are not excessive. But on the other hand, the limiting sizes of some houses are very small. From 10s. to £2 a ton will, in most cases, cover the extra cost of plates exceeding the limiting dimensions. If excessively large, £3 a ton may be charged.

In the inspection of plates, note of their brands should be taken before they are cut off or put together. Properly, also, when the nature of the work will permit of it, the brands should show conspicuously. For testing, strips should be cut from the plates before any work is spent upon them, and the inspector should stamp the strips, together with the plates from which they are cut, with private marks of his own.

The defects inherent in the method of manufacture of rolled iron, from which the homogeneous steel is free, are frequently apparent in lamination and blisters, due to the cinder and scale preventing the perfect union of the parts of which the pile is composed. These defects are sometimes to be detected by their black appearance when the plates or bars are red hot; or they may, if bad, be sometimes discovered by hammering a plate cold, the absence of a sonorous ring indicating a faulty plate. But frequently they are not discernible until the action of heat or of stress reveals their existence.

Fig 2

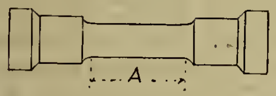


Fig 1

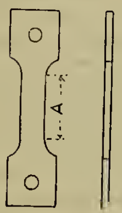


Fig 4

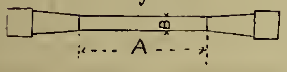


Fig 3

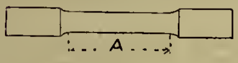


Fig 5

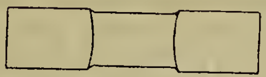
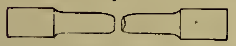


Fig 6



Another point in connection with rolled iron is that it is stronger in the direction of the grain than across the grain, a point to be borne in mind in the construction of certain classes of work.

An immense number of experiments have been made at different times to determine the tensile and elastic strengths of various kinds of wrought iron, by Barlow, Fairbairn, Lloyd, D. K. Clarke, Kirkaldy, Kennedy, Unwin, Anderson, Banschinger, Wohler, and others, and the deductions arrived at are extremely useful as generalisations. But since there are so many different qualities of iron in the market, and so many conditions operate prejudicially or otherwise on ultimate results, the only sure method is to test each plate or bar on its individual merits with reference to the special purpose for which it is intended. The pieces cut or shorn off are shaped into various forms according to the mode of testing employed.

The diagrams illustrate some forms of test specimens used. Fig. 1 is a piece of plate for pin shackles, the narrow portion of the specimen being that which gives the sectional area under stress. It is quite essential that there shall be no sharp reduction in section, but a curving inwards, as shown. Fig. 2 shows a specimen piece of bar, the shouldered ends being for grip shackles. Test pieces must always be so made that the pull of the shackles shall be strictly axial. The central portion is turned to give uniformity of area and parallelism, and the diameter is made some multiple or fraction of an inch. Fig. 3 is very similar to the last, but the mode of holding is different, the specimen being gripped with serrated jaws. Fig. 4 is a German standard test piece, the length, A, being 200 m.m., and the diameter, B, 20 m.m. Fig. 5 is Professor Thurston's test piece for torsion, the diameter being ⅝in. For compression, cylinders whose height is about twice their diameter are used.

The plastic character of wrought iron is evident at the testing machine. The material does not break suddenly with no previous warning, like cast iron, but it is gradually drawn out, so that a very considerable reduction in area takes place before fracture. The aim of testing, therefore, in this case is not altogether to determine the absolute breaking strength, but also the elastic limit, or the point at which the material begins to yield, or to become crippled. The central, strictly parallel portion of the test piece (A in the figures), is always of a definite length, usually 7in. or 8in., sometimes 2in. of English measure, and it is in this portion that measurement is taken and that fracture occurs.

The immediate effect of the testing is to lengthen the test specimen without any apparently localised differences in extensibility. But there is a definite and well-marked stage at which a rapid stretching takes place, and this occurs shortly after the elastic limit is passed, and is termed the "yield point." It is somewhat singular that after the yield point is passed the material is found to have acquired additional rigidity. This accords with the fact, which is known in a practical way, that by using up the natural elasticity of a material, it is rendered stronger, more rigid, than it was previously. But experiments have proved that this artificially raised strength is unstable, and that the raising of the elastic limit for one kind of stress lowers it for the stress of the opposite kind.

After the yield point is passed, the absence of perfect homogeneity determines a greater drawing out in one particular section than in any others, and in this section accordingly "reduction of area" begins to take place, and rapidly continues until the bar breaks, its appearance at rupture being much like that of fig. 6. The two conditions of strength and ductility, as evidenced by a high percentage reduction of area, cannot co-exist in perfection in the same specimen. For general purposes that wrought iron is best which has the highest strength possible with a good ductility. A hard, strong, impure iron may sustain a stress as high or higher than a soft, pure metal, but then its area will be only slightly reduced before fracture. But for special purposes one or other quality may predominate.

The reduction of area and elongation mainly take place in the immediate vicinity of the point of fracture. Although at the moment of fracture the diameter of the specimen is reduced by perhaps from 20 to 30 per cent, it is yet the usual practice to calculate the breaking strength on the basis of the original dimensions. Though not strictly scientific, it is more convenient in practice than to measure the elongation on the short length, which is drawn out at the last stage only.

The outer skin of a piece of ductile metal thus elongated presents a characteristic crumpling or shrivelling in the longitudinal direction, as though it were a viscous or semi-viscous material.

The processes of hammering, rolling, and punching cold iron have effects similar to those produced by chemical impurities and crudeness of manufacture, the strength being raised, while the elongation and reduction of area are diminished. Annealing restores the material to a more ductile though weaker condition. In the case of punched plates, rimering the holes larger has the same effect as annealing.

The aspect of a fractured surface varies with the manner of test and the quality of the iron. If a plate or bar is nicked and broken suddenly, its fracture will appear highly crystalline. If broken by a gradual bending or drawing out, the fracture will appear fibrous. But the broad differences in quality are apparent on inspection, for whether broken suddenly or slowly, the good iron will have a grain of finer and more silvery texture than the inferior quality, and the latter will be coarse, dark, and open by comparison with the other.

In the next article I shall give the principal commercial tests required in material for specific purposes. J. H.

(To be continued.)

THE STRIKE OF ABERDEEN SHIPBUILDERS.—The strike of iron shipbuilders at Aberdeen has terminated. The men asked for a rise of 2s. per week on time work, and 7½ per cent on piece work. The masters have conceded the demand as regards the time work, and given a rise of 5 per cent on piece work, at the same time offering to grant the full increase in November. At a meeting of the men these terms were accepted, and work has been resumed.

THE IRON AND STEEL INSTITUTE.

(Continued from page 412.)

After Mr. Adamson's paper on a compound-lever testing machine, the following communication was read by Mr. R. A. Hadfield, of Sheffield :—

MANGANESE STEEL.

The author said it would not before have been thought probable that the ordinary properties and nature of the metal iron could be so completely changed as it was now known to be by its alloy with a second metal, manganese. That new steel had drawbacks that at present interfered with its usefulness and commercial introduction. The chief one met with was its hardness. The majority of articles used in machine construction of any kind must be tooled, fitted, or adjusted to shape, and that was almost out of the question with this material—in fact, in its machining it might be described as equal to the hardness of chilled iron. Having referred to the early history of manganese, he said that a series of experiments was commenced at the Hecla Works, Sheffield, some few years ago, it being thought possible that steel with high manganese might give a hard material, somewhat like spiegeleisen, but without the brittleness of the latter, seeing that the carbon should be so much reduced. After many trials, a material was produced combining great strength with hardness, but the puzzling and apparently paradoxical result was discovered that although steel, if it might be so termed, with 4 to 6 per cent of manganese, and less than one-half per cent of carbon, was so brittle that it could be powdered under a hand hammer, yet, by adding twice that amount of manganese, just the contrary effect was produced, and a material was obtained containing many apparently new properties, as compared with any iron or steel hitherto manufactured. Briefly, the material might be described as follows : That containing from 2½ to 6 per cent was extremely brittle in its cast state ; then a return in strength gradually took place, and, with about 9 to 10 per cent, a cast bar 2½in. square could be bent considerably out of the straight without breaking. That continued up to about 14 or 15 per cent, when a decrease occurred in actual toughness, though not in transverse strength, and after about 20 per cent was passed, then a rapid decrease again took place. It should be stated that these remarks apply specially to the material in its cast state. Manganese steel was not so liable to honeycomb as ordinary steel, and the addition of silicon was unnecessary. It was very fluid, and could be run into thin sections, but cooled more rapidly than ordinary steel, and its contraction was decidedly greater. This latter fact explained the reason of its piping and settling so much, both in the ingots and in castings ; with proper heads or runners, however, that difficulty could be obviated. It was manufactured by any of the ordinary steel-making processes, the basis—*i.e.*, the material before the ferro-manganese was added—being preferably decarbonised iron, practically pure iron, or mild steel. The ferro-manganese was added in a molten state, or very highly heated. The steel was then ready for casting into ingots or other forms.

It was most important that the carbon should be kept as low as possible, especially in the 14 per cent material, where it should not exceed about 1 per cent, or the product would be inferior. For that reason the ferro-manganese used should contain high percentages of manganese, such as 80 to 84 per cent, now easily procurable at as low a price as £9 per ton. About 0·50 per cent of the manganese was oxidised—that was to say, to obtain a steel with about 13 per cent about 13½ per cent of manganese must be added. Proceeding to a more exact description of the qualities of the material, he dealt first with the manganese steel containing 2½ to 7½ per cent of manganese in its cast and forged state. With regard to the cast state, the brittleness of the cast material could not be too strongly emphasised, and it seemed difficult to believe that the material under examination could be a steel, or an alloy of steel at all. A specimen containing 0·37 per cent of carbon and 4·45 per cent of manganese broke with a total load of only 3¼ tons, against 10 tons for cast iron. In the forged state a remarkable increase in strength took place. Nevertheless it was still brittle, and commercially useless, the tensile strength averaging about 25 tons per square inch, with not more than 3 per cent elongation. Referring next to manganese steel, containing 7½ per cent of manganese and upwards, he said that in its cast state, after passing about 7 per cent an increase in strength occurred, and, with about 10 per cent, a 2½in. square bar would bend considerably before breaking, although with a comparatively low transverse strength, the latter rapidly rising as the manganese increased, but the samples with higher manganese and higher transverse strength were not so tough as that of the 10 to 14 per cent material. That material had been tested, and found well adapted, owing to its combined hardness and toughness, for couplers as used in coupling railway rolling stock in America, where nearly all cars or wagons have a coupler, draw-bar, and buffer combined in one. In grinding up a manganese steel axe, Mr. C. W. Hubbard, of Pittsburgh, Pa., noticed that the material possessed a close, hard, and peculiarly greasy nature, and he considered that it possessed the very essence of anti-friction. A bearing was put to work at the Hecla Foundry, under a shaft 2¼in. in diameter, carrying a load of 3 cwt., and after having been at work 2½ years it was but slightly worn. It was estimated that the number of revolutions made by the shaft had been close upon 5,000,000. As indicating its toughness, and showing how even practical steelmakers might be deceived in the appearance of its fractures, it might be stated that when the material was being tested at the Crescent Steelworks, Pittsburgh, the blacksmith to whom an ingot was given to break was inclined to be sarcastic as to the "scalded ingot" (10·89 per cent), as it was termed, and said that it would be easily broken with a sledge-hammer. Not only was he unable to do this, but ten blows from the steam-hammer were required to cause a fracture.

Another important use of that material, and one which led to the commencement of these experiments, was its application as a hard material for car and other wheels, to compete with those made of chilled iron in America and elsewhere. Wheels of that class had been used with satisfactory results. On the Nottingham tramways a set ran over 30,000 miles under severe conditions, the gradients averaging as much as 1 in 18 for about one-half the route of the daily journey. In that case a peculiar point was noticed, viz., that whereas the cast-iron wheels are liable to slip when going down an incline, the chilled brake-blocks bite much more effectively on manganese wheels, enabling the car to be stopped sooner. The Chester Tramways Company had had a set running for over two years, which up till now have run over 45,000 miles, and are not yet worn out. Wheels of that description could be tested with more than one hundred blows with a heavy sledge-hammer without fracture occurring, and at the same time the tire was so hard that a chisel would not touch it. A set put to work in America had already run 200,000 miles, under heavy engines of the consolidation type, on the New York and New England Railroad. The life of ordinary chilled iron wheels did not average more than 50,000 miles. With reference to the forged material, it was worth contrasting the brittle 5 per cent manganese steel, which could be powdered cold with a hand hammer, and yet contained only as much carbon as mild steel, with specimens containing two and a half to three times that amount of manganese.

As before pointed out, after passing about 14 per cent the material again lost strength. This was no doubt owing to the higher amount of carbon necessarily present. Nevertheless, it had been possible to forge specimens with 20 and even 22 per cent manganese and over 2 per cent carbon. Thus, whilst an alloy of 97¼ per cent of iron and 2¾ of carbon was practically unforgable, an example was here met with where an alloy of 78 per cent of iron, 2 per cent of carbon, and the rest manganese was quite malleable. Ingots and castings, containing 14 per cent of manganese, and weighing 28 to 30 cwt., had been successfully cast and forged ; these may be termed fairly large pieces. Tests were made to compare the forged and water-toughened manganese steel (12·55 per cent manganese) with the best quality of steel as now used in railway axles. The results of these tests showed that on the manganese steel bar or axle an energy of 498 foot-tons only produced total deflections of 39in. (*i.e.*, the sum of all the deflections), whereas in the special steel axle an energy of 48 foot-tons produced total deflections of 105¼in. Manganese steel, notwithstanding its high proportion of metallic iron—the most magnetic metal known—possessed the peculiar property of being almost entirely non-magnetic. In analysing that material no trace of graphite was found, all the carbon present being in the combined form, and except that the drillings took more time to dissolve than ordinary steel, no difference was required in their treatment ; both the ordinary colour and combustion tests gave the same results in testing for carbon. The specific gravity of the cast sample (13·75 per cent manganese) was 7·83, the drawn wire 7·81 as determined by Professor Barrett, and 7·83 from the same wire at the Hecla laboratory.

It had been stated that an excess of manganese in ordinary steel produced a metal more subject to corrosion by sea water, but from experiments made at the Hecla laboratory in regard to that steel it did not seem to be so. In diagrams representing respectively test pieces from a Bessemer steel rail, a Siemens steel plate, and a basic steel plate, attention was drawn to the early permanent set noticed even in the mild Siemens steel test bar from the plate. It was seen that the ordinary yield point, as commonly noticed, was not altogether correct, as when the measuring was done by means of accurate apparatus the permanent elongations there referred to were, of course, only minute, but they were distinctly measurable. The mild Siemens steel specimens in question had a yield point at as low a stress as eight tons per square inch. Still more marked was the low permanent set point noticed in the basic steel sample, namely, six tons per square inch, or about the same as the "water-quenched" manganese steel, the ultimate tensile strength being, however, respectively 22 tons with 26 per cent elongation (basic steel), as against 56 tons and 38 per cent elongation (manganese steel). Diagrams were given to show the striking differences noticed between the curve representing the ordinary steel and one of manganese steel, the respective tensile strengths being 27 tons per square inch with 30 per cent elongation, 8in., and 63 tons with 42 per cent elongation.

In the discussion that ensued on the paper M. Gautier mentioned that the first employment of manganese steel in France was in the making of horse shoes. The metal had 12 per cent of manganese, but the difficulty they experienced was that the manganese nails were not susceptible to any file. They had, therefore, to use nails of softer steel, and as they were hammered flush with the shoe, they could not be worn to any greater extent than it. Good success also attended experiments in casting, from manganese steel, wheels for small mining cars; although they had some difficulty in taking the cast quickly enough out of the mould so as to avoid cracking or shrinkage. Manganese steel was likewise used for the production of armour plates. They found it was too high in carbon for that purpose, and they hoped to reduce the carbon and make a better quality of steel. Going on to say a few words on the question of the presence of carbon in manganese steel, M. Gautier remarked that the less carbon they had in it the better it would certainly be, though it was impossible practically to make manganese steel of high percentage—of 12 per cent, for instance—without having a high percentage of carbon also.

Mr. Snelus, Workington, said that in some experiments which he conducted three or four years ago he not only got too much carbon into the manganese steel, but he found that the silicon had increased for some reason or other, and was present in an abnormally high degree. He would like to ask Mr. Hadfield whether, in making these alloys, he had found any difficulty in keeping out the silicon?

Mr. Gilchrist, London, put a question with reference to the matter of cooling as affected by the proportion of carbon.

Mr. Sterry Hunt, New York, asked how far in the investigation of these alloys there had been careful determinations of the important question of specific gravity?

Mr. Hadfield, in reply, said he could hardly offer any explanation of the peculiar fact Mr. Snelus noticed. They found, if they did not add silicon, they did not get manganese steel. As regarded Mr. Gilchrist's remarks, he was afraid, even if the carbon was reduced, it would not enable this steel to be any the more readily cooled. It was the manganese which eventually caused the hardness. There was no doubt about that. He thought there was great force in what Mr. Hunt said. Of course, in taking the specific gravity of this material, he did not see how it would be possible to separate. The manganese was weighed along with the iron. He did not see how it would be possible to get at the specific gravity except as a whole, and that corresponded very much with the ordinary steel. He thought, however, the point he mentioned was well worthy of consideration, and he hoped others might bear that in mind.

On the motion of the Chairman, Mr. Hadfield was thanked for his paper.

(To be continued.)

THE FIRST CENTURY OF THE MARINE ENGINE.—III.

(Continued from page 401.*)*

The first vessel with compound engines by Randolph, Elder, and Co. was the screw steamer Brandon. She made her trial trip in July, 1854, when her rate of consumption of coal was found to be about 3¼lb. per indicated horse power per hour. The lowest rate of consumption of coal in steamers previous to that time was about 4lb. to 4½lb. per indicated horse power per hour. Engines of a similar type had been made long before by Hornblower and Woolf, and had been used to a considerable extent on land, and occasionally in river steamers, but Randolph and Elder were the first to employ them for marine purposes. The second and third ships by this firm fitted with compound engines were the Inca and the Valparaiso, for the Pacific Steam Navigation Co. The engines of the Inca were started in May, 1856, those of the Valparaiso in July, 1856, and were designed according to the specification of Charles Randolph and John Elder, dated March 15, 1856. The pressure of steam used was 25lb. above the atmosphere. There were four cylinders: two high-pressure of 50in., and two low-pressure of 90in. diameter, all steam-jacketed at the top and bottom, but not round the sides. The cylinders were inclined to the vertical; the two high-pressure opposite each other, one on either side of the crank shaft, and both working on to one crank; while the two low-pressure cylinders were similarly arranged with regard to the other crank. The condenser was of the old-fashioned jet description, and was placed between the two sets of cylinders, underneath the crank shaft. On the trial trip, and during many years' subsequent service, the consumption of coal in these steamers was from 2½lb. to 3lb. per indicated H.P. per hour—a degree of economy never before realised in marine engines, amounting as it did to a saving of from 30 to 40 per cent of the coal previously burned by steamers of the same class.

This success induced the company to have their whole fleet fitted with engines of the same type, as to them the question of coal economy was of vital importance, owing to the great cost of sending coal to the Pacific stations. The next set of engines made for the company was of exactly the same size, and was worked with the same pressure as the engines of the Valparaiso, but with the difference that they were steam-jacketed all over, instead of merely at the ends; and the result was that the indicated power rose from being under 900 to 1,150 horse power—a result which shows the advantage of the steam jacket if used under proper conditions.

For a good many years, however, little progress was made by the compound engine, except with the company which had introduced it. Some others had compound engines made by various makers, but bad design prevented them from being so successful as they ought to have been, and in a few cases they were taken out and replaced by single-cylinder engines. Moreover, the engines of the Woolf type designed by Randolph and Elder were not fitted to give the highest efficiency, and it was not till the "receiver" type of engine, with cranks at right angles, was introduced by Nicholson, and brought prominently before the public by Mr. E. A. Cowper, that the compound marine engine became almost universal in the merchant service. Until about 1868 or 1870 the inverted direct-acting two-cylinder simple engine held the place in the mercantile marine formerly occupied by the side-lever engine. At these dates, however, the paddle wheel had been almost entirely superseded by the screw in the propulsion of ocean-going steamers.

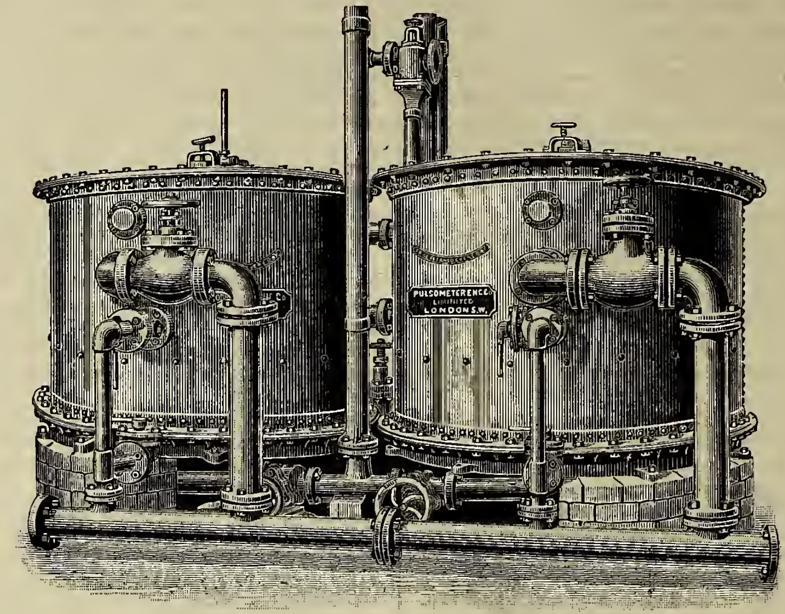
A few sentences of a theoretical nature may here be allowed. From the principles of thermodynamics we know that in any steam engine the heat converted into mechanical work is to the whole heat received as the range of temperature is to the absolute temperature at which the steam is received. We may increase the range either by raising the temperature at which the heat is received, or by lowering that at which it is rejected. Various attempts have been made with this latter object in view, but for all practical purposes we may consider the temperature of the condensing water as the lower limit. The lower limit being thus fixed, the only thing left is to increase the initial temperature either by directly superheating the steam or by increasing the pressure, and thus also raising the temperature. When steam of low pressure was employed in marine engines, it was not unusual to superheat it to a considerable degree above the temperature corresponding to the saturated condition; but now that higher pressures have become common, superheating has been almost entirely abandoned, and further economy is now attempted chiefly by raising the pressure of the steam and improving the method of expansion. Experience shows that the economy of steam engines does not necessarily increase with the increase of the pressure of the steam and the rate of expansion, and many have found that expansive working often means expensive working. When the pressure remains constant, and expansion is augumented, at first there is a diminution in the consumption of steam; then it increases, and for each pressure there is a ratio of expansion which gives the maximum efficiency; and it may be stated generally that in all classes of engines the efficiency depends not only on the *amount* but also on the *method* of the expansion.

(To be continued.)

Patents in 1887.—The report of the Comptroller-General of Patents, Designs, and Trade Marks for the past year states that the total number of patents applied for was 18,051, being an increase of about 900 on the year before; of designs, 26,000 as against 24,000 of the preceding year; and of trade marks, 10,586, being a decrease of 91 from the preceding year.

TORRENT FILTER.

CONSTRUCTED BY THE PULSOMETER ENGINEERING CO., OF THE NINE ELMS IRONWORKS, LONDON, S.W.


PULSOMETER ENG. CO.
LIMITED
LONDON S.W.

THE illustration above represents a form of filter made by the Pulsometer Engineering Company, and has been specially designed for treating large quantities of water, such as are required for manufacturing purposes. The construction adopted in the filter shown is the outcome of a large experience which the firm have had in this class of work. Experience with water impregnated with various kinds of impurities has led the firm to adopt a granular filtering material, as being on the whole best calculated to effect the object in view, while it also lends itself very readily to the process of cleaning by compressed air, which is one of the special features in connection with the filter.

The filter is already in extensive use, and has proved of considerable advantage to steam users, as it frequently enables water to be used which would otherwise be unavailable, and in many cases enables the expense attendant upon the use of service water to be avoided.

The Metropolitan Board of Works have selected this filter for filtering the Thames water for the boilers at their sewage outfall works, North Woolwich, and the firm have now four large filters on order for this installation. The filtering vessel or body of the filter is of wrought iron, and contains a layer of charcoal and other granular material, resting on a perforated bottom, covered with wire gauze. The thickness of the bed of filtering material varies according to the quality of water to be treated. Under the filter bed is a distributing arrangement for affording a passage for a number of small jets of air, supplied by a pump or blower to all parts of the bottom.

The inlet for the dirty water is above the filtering material, the outlet for the clean water at the bottom of the apparatus. An outlet is provided at the upper part of the apparatus for the rapid exit of all the accumulated dirt during the process of cleaning. The filters are usually made close-topped, but access is given to all needful parts by manholes. The working of the filter goes on without diminution of quantity or deterioration of quality for a number of hours, varying with the character of the water, from five as a minimum to perhaps thirty or forty as a maximum. The filter should, however, be cleaned every ten hours, as, even if this is not necessary, the material will be kept in a better state of efficiency.

In cleaning the filter, the ordinary supply and outlet cocks are closed, and the inlet pipe for the cleaning water is opened. The outlet pipe for the mud which has to be washed away from above the filtering medium is then opened. The cleaning water from below, which need not in most cases be clean water, now rushes up and fills the filter, and passes out through the outlet pipe for the mud. This is the old simple reverse current, and it has little effect in washing away adherent impurities. But as soon as the cock for admission of the high-pressure air is opened, the whole of the filtering material and contained impurities are set in violent agitation, and the particles of dirt are thoroughly loosened by the friction of the materials and the air and water, without damage to the grain of the filtering material. Through the mud outlet passes a stream containing all the matter deposited during the last ten hours, which becomes gradually clearer as the air and water do their work, until after the lapse of a few minutes the discharge has the same tinge as the original sample of water which was to be filtered. The operation is then complete, and the filtering material settles down into its old position in less than thirty seconds. An installation of these filters for a foreign waterworks, filtering 20,000 gallons of river water per hour, occupied a space in plan of 7ft. 6in. by 37ft. For an ordinary sand filter bed for this quantity of drinking water the space occupied would be, if on the same scale as those of the London companies, about twenty-five times as great as this.

DEFECTIVE VALVE DESIGN.

OUR previous article on "Defective Valve Design" (*Practical Engineer*, July 27th) was intended mainly to show how easily one may be misled by indicator diagrams, and how erroneous conclusions may be arrived at when the circumstances and conditions of working are not fully known. The low-pressure diagrams were not given, partly in consequence of want of space, but principally because they did not bear much upon what it was mainly intended to illustrate in the article, and because our information respecting the valves and steam ports of the low-pressure cylinder was not so complete as that which we gave of the high-pressure cylinder. As considerable interest, however, has been evinced in the article, and a desire has been expressed to see the low-pressure diagrams, we this week revert to the subject, as promised, and copies of the low-pressure figures are given herewith (figs. 4 and 5). For convenience of reference, we also reproduce the diagrams given in our previous article. From figs. 4 and 5 it would appear that the valves of the low-pressure cylinder had been altered between the time of taking the first and second set of diagrams, so as to carry on the steam further through the low-pressure stroke, but of this we have no positive information. The diagrams were taken several years ago, and the only information we have respecting the low-pressure valves and ports is that the valves were worked by a rocking lever, so that the traverse could be varied, and that the valves were ⅝in. short of cover at each end on the exhaust side, similarly to the negative "lap" on the high-pressure valves. This appears to have been a very common defect with the valves made by the makers of these engines, the idea apparently being to facilitate the escape of the steam, just as "lap" on the steam edge of the valve does, and in the case of condensing cylinders to cause the vacuum to be early formed, and its maximum effect obtained on the piston as early in the return stroke as possible. Where the steam release is late—as, for instance, when valves have no "lap" on the steam side—the escape often appears to be made with difficulty, especially where the ports are not of ample area; but with ⅝in. negative "lap" on the exhaust side, as in this instance, the steam will be escaping into the condenser from both ends at once, and when the exhaust at one end is closed, the other steam port will be open 1¼in. to the exhaust. This will, doubtless, account to a large extent for the very poor effect of the vacuum obtained in the L.P. cylinder shown by both sets of diagrams, the maximum in the case of fig. 4 being only about 8½lb., and in fig. 5 about 9lb., the vacuum in the condenser at the same time, as indicated by the vacuum gauge, being 11½lb., and the temperature of the ejection water in the hot well 140 deg. Fah.

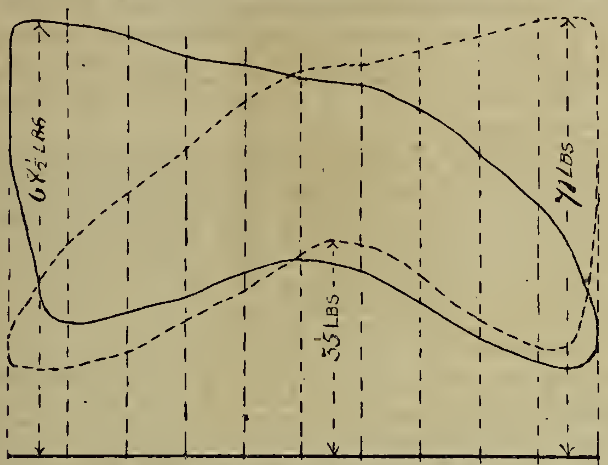


Fig. 1.—Diagrams with full traverse of valve.
Scale: 32lb. equals one inch.

If now we set out the curve of spaces for the H.P. crank and piston, and also for the eccentric and valves, with the 8½in. traverse, and also with the reduced traverse of 6¼in., we can see exactly how the defective valve design will affect the distribution of the steam, and by noting the different points in the piston's stroke, where admission, release, compression, &c., take place, it will not be difficult to reason from these what will be the probable effect on the diagrams.

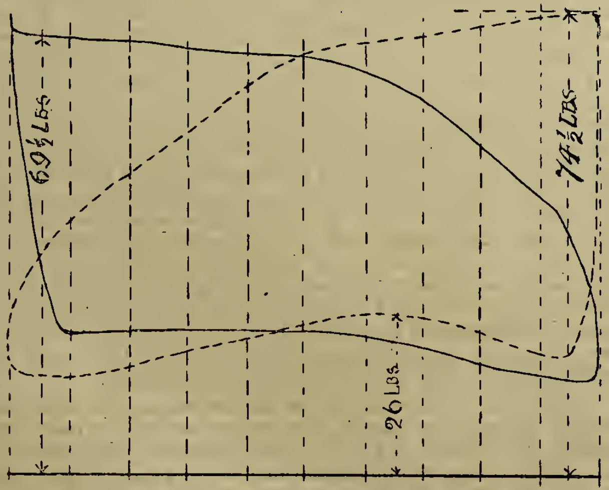


Fig. 2.—Diagrams with reduced traverse of valve.
Scale: 32lb. equals one inch.

For convenience of reference, we reproduce the sketch of the H.P. valve and ports shown previously in fig. 3. The valve being drawn in its middle position, and the traverse being 8½in., it will be seen from the dimensions figured on the sketch that when it has moved the remaining half (4¼in.) of its stroke, the back edge of the valve will have moved $\frac{7}{16}$ of an inch over the exhaust port (since 2½in. + $1\frac{5}{16}$in. + $\frac{7}{16}$in. = 4¼in.), so that "live" steam from the steam chest will be admitted on the exhaust side of the H.P. piston when the latter has moved (as shown on our curve of spaces) about ·06 of its stroke from one end, and (owing to the obliquity of the connecting rod) ·07 of its stroke from the other end. The piston's stroke is 6ft., so that we may give the distance exactly, by saying that when the piston has moved 4¼in. from one end of its stroke fresh steam is admitted on the exhaust side, and the same thing happens at the other end of the stroke when it has moved 5in.

Reference to our curves of spaces further shows us respectively that when at the extreme end of the valve's stroke—*i.e.*, when the exhaust port is open to the steam chest, 7-16ths of an inch at the back edge of the valve—the piston has travelled 14in., or nearly two-tenths (one-fifth) of the stroke, and that the port is closed again by the back edge of the valve returning when 3½-tenths or 26in. of the piston's stroke has been travelled over. We thus see that while the piston has been moving from 14in. to 26in., a distance of 12in., or nearly one-fifth of the stroke, fresh steam has all the time been admitted on the exhaust side of the piston, owing to the defective valve arrangement.

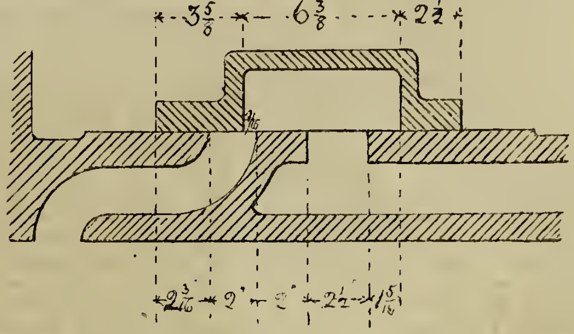


Fig. 3.—Middle position of valve at front end.
Traverse, 8½in.; lap on steam side, $2\frac{3}{16}$in.; exhaust, $\frac{9}{16}$in. short of cover or negative lap.

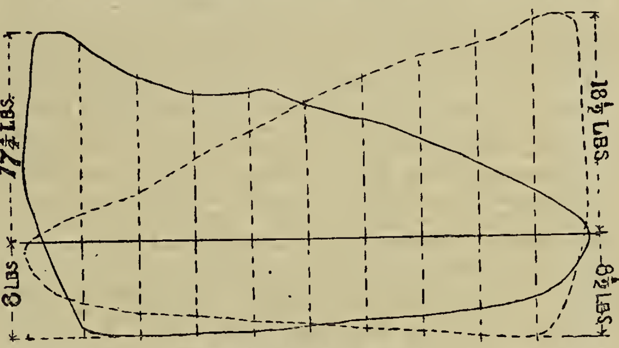


Fig. 4.—Diagrams taken before alteration of traverse of high-pressure valve.
Scale: 16lb. equals one inch.

It was pointed out in the previous article how the exhaust port was closed up by the inner edge of the valve. With a properly designed valve it should have really been open a full port; and the points of closure and re-opening of the exhaust, it will be found on examination, coincide exactly with the points of re-admission and closure to live steam above referred to, because the back face of the valve is precisely the same width (2½in.) as the width of the exhaust port, which it just covers, so that one side of the port is opened just as the other side is closed.

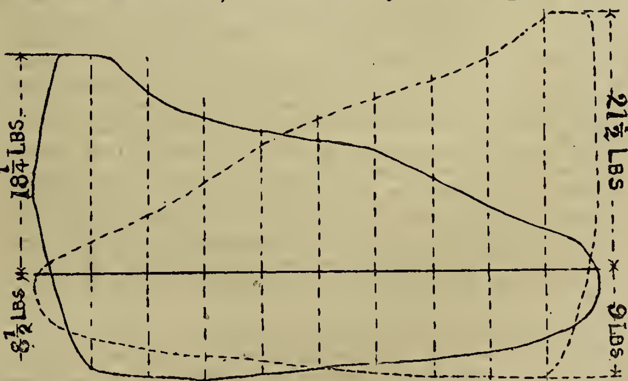


Fig. 5.—Diagrams taken after reduction of traverse of high-pressure valve.
Scale: 16lb. equals one inch.

The cranks being at right angles, the low-pressure valves do not open to steam until the high-pressure piston has travelled nearly half its stroke (2ft. 8in., as shown by our "curve of spaces"), so that from 26in. distance to 32in. the high-pressure piston has been reducing the volume occupied by the steam on the exhaust side of the piston, and in the exhaust pipes or receiver (in other words "compressing"), all the while that the pressure has been augmented by the further admission of "live" steam. We are thus led to infer that the diagrams should show a rapid rise in the exhaust line from before or about the first-tenth to the middle of the stroke, and this we find, on reference to the figures, is the case, the back pressure falling rapidly afterwards when the middle of the stroke is reached, owing to the admission of steam to the low-pressure cylinder taking place.

Close investigation into all the circumstances of this interesting case of malformation of valve reveals to us, therefore, not only that the position of cranks is not the principal cause of the abnormally rapid rise in the back pressure line shown by the diagrams, but that it is largely due to the closing up of the exhaust port in consequence of the valve cavity having been made too small; and the evil is still further aggravated by the defective valve design causing a fresh admission of live steam on the exhaust side of the H.P. piston during nearly one-third of the entire stroke. Our correspondents who have written in reference to this cannot do better than carefully study every phase of the above problem, as we know nothing which so effectually familiarises an engineer with indicator diagrams as the investigation of cases of this character, and the consideration of the alterations which might be looked for in the indicator diagrams under any supposed conditions.

AN ENGINEER'S LIFE AT SEA.—XIII.

BY A SEA-GOING ENGINEER.

Winches and Donkey Pumps.

Among the auxiliary engines on board, the winches, by their position and obtrusiveness, hold a prominent place. There are usually three, one for each hold, and in overhauling them advantage is taken of the first fine days after leaving port, the third engineer taking charge of the two forward winches, and the second of the after one. Sometimes, however, both second and third together look after the three. After the rough usage they frequently get in port, there are sure to be brasses to be stripped, nuts to be tightened, and stuffing boxes to be filled. Keys also work loose and have to be caulked, and as far as possible the shake must be taken out of the valve motion and levers. In breaking joints, it is well to turn on steam first, so as to warm up the winch, though some chiefs object to this on account of the waste of fresh water in the steam. As a rule, all studs, bolts, and spindles on the winches are made so light that they are easily broken, and every care has to be used with them. The locking of the nuts on the connecting rod ends must be carefully looked to if breakdown in port is to be avoided. A summons in the middle of the night to attend to a broken-down winch is by no means agreeable, and as the engineer turns out it is usually with a sincere wish that the damage may be extremely slight, or else so bad that he cannot repair it with the tools on board. Pistons and valves must be occasionally overhauled, for with these leaky, the winches, which are always overworked, will soon run away with all the water out of the donkey-man's boiler. This boiler also is frequently too small, and sometimes one of the main boilers will have to be lit, but only in extreme cases should this be resorted to, and some engineers absolutely refuse it in almost any circumstances. A donkey-man, in self-defence, usually shuts his stop valve so far that there is only enough steam to drive the winches at a reasonable speed, and thus his water is not spirited away so fast by priming. The stevedore then will stealthily open any stop valve he can get at, and insist that it worked itself open. He will also prowl about the donkey boiler, and try, by persuasion or craft, to get its stop valve wider open, but when steam falls in consequence he is the loudest to complain.

Second-motion clutches must occasionally be worked, for the starting of them when once rusted up is not always easy. Steam pipes also get corroded by sea water washing about them, and have to be lapped till a new length can be got. Expansion, and contraction also, by causing the pipes to creep backward and forward, will frequently start joints.

In starting the winches the donkey-man should see that the winches are oiled round, the oil being provided from the deck stores. He must see that the drain cocks are open at starting, and will usually take care that they are not open too long. If the weather is frosty, then when the men stop at night all water must be drained out of the pipes, or a frozen-up winch will be found in the morning, and perhaps a split pipe. Possibly, also, an engineer may have to turn out to superintend the pouring of hot water on the frozen pipes, with impatient cargo-men and mates assisting.

As soon as a steamer nears port the rattle of the winches begins, either to warp the ship into dock, or to get out the anchor and raise the booms to act as derricks. With all this the engineers have little to do, as the sailors drive the winches themselves. It is always a welcome sound to an engineer to hear the running out of the chain, which tells of an anchor down, and perhaps then will cross his mind a humorous memory of the mate who forgot to secure the end of the chain, and looked over the side just in time to see the last of it disappear after the anchor.

In leaving port, the forward winch, with its active messenger chain, leaves the anchor, and while the engineer looks on at a distance the anchor chain seems of interminable length as the wet links creep on board, one by one, with green and dripping seaweed attached.

When anchored in open roadsteads, enough chain is paid out to let the ship swing with the tide, but if in an exposed situation, in addition to this the main engines must be under steam, and anchor watches kept. This is in case of sudden squalls striking the ship and causing the anchors to drag. Not only has the mate to watch if objects on shore retain their relative positions, the vibration and grinding of the anchor chain not being a sure guide, but he and the engineer must also be ready to get out of the way of other drifting ships at short notice.

Whoever has once kept an anchor watch at night will never forget it. The unusual silence and stillness of the engines, which have throbbed and laboured beside him for weeks without resting; the darkened engine-room, where there is little more for him to do than listen to the monotonous rush of water backwards and forwards in the bilges; the deserted decks; the stationary lights on shore, with their broken reflections in the bay; the cool night air singing to him; the faint sweet scent of vegetation; the black hull, with the moving waters below; the slender masts and transparent tracery of the cordage, sweeping in arcs of circles across the clear and steady stars—these and a thousand indefinable memories return with the recollection of anchor watches.

As a rule, however, unloading of cargo begins as soon as the ship reaches port. For this the donkey boiler has to be lit some time previously, to have steam up. It need hardly be said that the practice—not quite unknown—of turning steam from the main boilers into it to get up pressure more rapidly is a most injurious one, straining the plates with irregular expansion. With a safety valve out of order (as may well happen with such an engineer), the working pressure of the boiler may also be dangerously exceeded. As soon as the lighters are alongside, then to the clatter of the winches is added the shouting of the cargo-men. The firemen being held in readiness, as soon as the engines are "rung off" fires are drawn, the boilers closed up, whether blown down or not, the safety valves eased, while in the engine-room the "wiping down" of the warm engines proceeds. Then, whatever valve or cylinders are to be overhauled, have their nuts eased back while hot. The "second" is superintending work; the "third" is pumping out the bilges, if these are not already dry; and everything is got in readiness for the next day's work. As soon as this is done and the turning gear in, the men knock off for the day, for they have been at work through the night. They work hard and willingly to get finished; but if they think that they are to be given other work to do, without urgent cause, then they will try to take the whole day to this "wiping down," and it will be worse done. By thus trying to extract the utmost from them, the feeling of good fellowship is soon destroyed, and all their work for the rest of the voyage will be done in the spirit of each looking out for himself.

Besides the overhauling of the winches at sea, the ballast and donkey pumps have to be in order on arrival at port. The ballast tank, besides its special work connected with the tanks, can also be put on the bilges, and for this, in a case of emergency, it is invaluable. The large size and lightness of its rubber valves enable it to throw a large volume of water, and any dirt from the bilges is not so liable to stop the pump as with the regular donkey, whose brass valves have to be made heavy and strong enough to pump water against the boiler pressure when required. The ballast donkey is also used to turn the engines when these are fitted with steam-turning gear. Probably of all the machinery in the ship the ballast donkey will be found to give least trouble, and the ordinary donkey the most. Besides being larger, its work is much simpler. It pumps the ballast and bilges, but the other donkey has much greater variety of work, and with the bilges frequently gives trouble. All the pumping power of the ship is made to bear on the bilges. Ballast and donkey, main engine, bilge pumps, and deck hand pumps, as well as circulating pump, can all be turned on the bilges. The reason is obvious, for this, the most vital part of a vessel, is also the most vulnerable. Whatever happens, the ship *must* be kept afloat, or all other arrangements are vain. Should there be no bilge pipe on the engines for circulation or jet condensation, the engineer must be prepared in the last extremity to uncouple or knock a hole in the sea suction. He must of course shut down the sea valve first, or he will sink the ship. Only in great extremity should bilge water be put into the condenser, for without clear water the condenser will soon choke up and overheat, and the air-pump valves give out. With a sinking ship, however, the water will be only too clear and abundant.

TRADES UNION CONGRESS.

The 21st Annual Congress of Trades Unionist Delegates opened at the Technical College, Bradford, on Monday last. At the commencement of the proceedings Mr. George Shipton, of London, presided, and there was an attendance of 162 delegates, representing 590,045 constituents. With the exception of the Hull Congress the present stands at the head the congresses in point of attendance.

The Chairman said that this was the day on which their congress came of age. It was impossible to enumerate the vast beneficial changes of legislation on behalf of labour during that 21 years. He was going to offer one or two observations upon what appeared to him the admission of very important principles which were pregnant with the most signal consequences to labour in the future, and which had taken place in the past few years. The first was the definition of what was meant by free trade in its relation to labour; and secondly, that the great Powers of the world, the enormous empires, had come together, and by mutual concession and argument had arrived at a unanimous decision, in principle at least, as to their action in the future. With regard to free trade, they had the old nostrums trotted out to them that they should buy in the cheapest market, quite regardless of consequences and the conditions by which that cheapness might be produced. If that absolute cheapness were good, then let them import Oriental labour into western civilisation—let them endorse and encourage the sweating system. (Hear, hear.) They had at the present a leading London organ, preaching through one of their esteemed Radical friends, that free trade meant buying in the cheapest market and selling in the dearest. He was surprised that a man holding the position of a legislator should preach any doctrine of that kind. He must know that any such doctrine as that had been exploded during the last half-century. It simply meant the jugglery of the markets. How was it possible to take advantage in one market or another in these days of steam navigation, and of the telegraph and telephone, which could whisper rates of the markets all over the world? Under such conditions tricks were impossible in one market or another, and such a suggestion did not represent free trade or any principle of national economy. If from despotic Russia in the north, to Republican France in the South, 12 of the most powerful empires in the world could agree with regard to a particular industry to unite upon a policy which should be mutual and just to one another, he hoped that principle might be carried still farther, and that whilst Europe was an armed camp, something would be done to relieve the workers of the incubus upon them. He hoped that working men would repudiate this idea of cheapness, regardless of the conditions and means by which that cheapness was produced. If it were adopted, why should they pay more for their coals because they were got by unionist colliers, or pay more for their clothing or bread because they refuse to have their clothing made under the sweating system or their bread under conditions which shortened the lives of bakers? (Hear, hear.) He thought they should draw a distinction between the two lines of protection—protection as a defence against injury and wrong, and protection which was simply in favour of those who would rob them of their just rights. He trusted they might always keep in mind Mr. Richard Cobden's definition of free trade.

On the motion of Mr. Rotheray (Bradford), seconded by Mr Cowgill (Bradford), Mr. S. Shaftoe, of the Bradford Trades Council, was unanimously appointed president of the congress.

The newly-elected President having thanked the delegates for the honour they had done him,

The Mayor of Bradford (Alderman J. L. Morley) gave the delegates a cordial welcome to Bradford, and said that there was, he believed, a greater horse power engaged in manufacture in Bradford than in any other town in the kingdom, and they had the satisfaction of knowing that work had been more regular in Bradford than in most towns.

REPORT OF THE PARLIAMENTARY COMMITTEE.

Mr. Henry Broadhurst, M.P., secretary of the Parliamentary Committee, then read the report of that committee. This referred to various subjects that had been before the Houses of Parliament during the past session. With regard to the Lords' Committee's inquiry into the sweating system, adjourned until next session, the committee said the trades would await the result of the inquiry with great interest, and with some expectation that it might induce the Government to adopt the recommendations of past congresses, especially in the direction of making a large increase to the present staff of factory and workshop inspectors. The Parliamentary Committee, at the request of the Glasgow Trades Council, drew the attention of the Government to the importation of foreign pauper labour, notably in the case of some ironworks in Scotland. No satisfactory reply had been received from the Government on this matter. A Select Committee of the House of Commons had been sitting during the year to inquire into this subject, but up to the present time no report had been presented. From what the committee could learn, the gross number of pauper immigrants had been much exaggerated; but this, of course, did not dispose of the grievance, which was one of great consequence to the working people of the country, and, if left to itself, might become a serious national danger. It would be the duty of the trades to keep the question under close observation. Remonstrances had been received from most influential quarters as to the diversity of the questions dealt with by the congress, and the recent tendency to drift into political and controversial subjects outside the scope of trade unions. The complaints were not exceptional and incidental; they were both numerous and important, and could not therefore be ignored. The congress was a non-political body, and its deliberations should be confined to strictly trade questions, and it should be the aim of all friends of trade-unionism to prevent the annual meetings becoming a national receptacle for the promotion of the private interests of all sections of the community. Neither should there be allowed in congress subjects for debate which excite religious or national antipathies and passions. In the latter part of the report, the committee congratulated the trades on the comparative industrial peace experienced since their last meeting. No great national labour contest had occurred to strain the resources of their unions, or to disturb the relations between capital and labour. They thought that, on the whole, trade had improved, and that no general reductions had been made in wages; but, on the contrary, there had in some industries been a tendency for the rate of wages to increase. During the year the principles of trade-unionism have made considerable progress. One of the main features of trade combinations was to contend against and to attempt to destroy the immoral system in the industrial world known as sweating. They took it as a compliment to their institutions that this matter was now the subject of investigation by a committee of the House of Lords, and that which they had contended against for generations was now being recognised as a national evil. The committee congratulated the congress and the trade unions of the country on the present signs of the awakening of the public mind to some sense of its duty towards labour. The trade combinations by their effective work had to a great extent brought this about, but they cared not who got the praise so long as their fellow-workers got the advantage. They thought, however, they had said enough to give a sufficient answer to those who said that trade-unionism had missed its mark, and had been of little service to the people. In conclusion, they appealed to the unions to show increased activity in the extension of their membership, the strengthening of their organisation, and the widening of the sphere of their operations, in order that the work of the complete emancipation of labour might be carried to a successful consummation.

President's Address.

The congress resumed its sittings on Tuesday, Mr. S. Shaftoe, the president, occupying the chair. There was a large attendance of delegates to hear his opening address.

The President, after welcoming them to Bradford, drew their attention to the great success of the movement. Old prejudices had been laid low, unjust capitalist laws in the main had been abolished, the hours of labour had been reduced, and the wages and comforts of the people had been greatly advanced since their first meeting at Manchester 21 years ago. Men no longer spoke with bated breath on the necessity of combination. They now cried aloud for a labour party. After referring to the trials of prosperity and adversity through which their organisations had gone, he said that the commercial depression had the appearance of passing away, and brighter prospects were in store. He congratulated the workers in various industries who had secured advances of wages, in many cases by amicable means. Although many admirable measures had been passed, all being steps in the direction of industrial emancipation, it must not be assumed that the character of capitalism had changed. It was the same to-day as when it struggled so hard against unshackling labour. Capitalism in its struggle to acquire more would work labour 15 or 18 hours per day and expect it to live on almost nothing. It is against this tendency that trades unions fight. After detailing a number of measures promoted by the congress, he paid a touching tribute to the pioneers of the congress, believing the seed they had sown would bear good fruit. Labour could not, he remarked, remain satisfied with the Employers' Liability Act nor the Mines Regulation Act, and it would not remain silent, as millions were spent on useless wars while a grudging Home Office starves the factory inspectorate and allows workshops to be unvisited for years. It demanded that the logical conclusions of royal commissions should be carried out. As long as labour had wrongs to redress, capitalism to check, economic laws to guide, and rights to maintain, so long would such annual gatherings be necessary. Being on the threshold of great changes, they could not stand still. On the one hand they had the competition of new mechanical inventions, and on the other a continuously increasing population. Labour-saving machinery, properly applied, and under a better system of society, would carry hope and sunshine, health and happiness, to thousands who now live under the grinding bondage of acute poverty. Under its ceaseless operations and the long hours worked the flooding of the labour market was largely brought about. After giving a number of striking instances of how manual labour had beeen displaced by machinery, he showed how, during the last 30 years, the saving of labour was 40 per cent in producing any given article. In his opinion something like unanimity was evidenced in favour of an eight hours' day. Considerable division, however, prevailed as to how it should be secured, whether by an act of Parliament or combination. This division of opinion was less marked among the miners and railway servants. The railway monopoly was a grievous sinner in the matter of overwork. Neither the safety of the public, the cheapness of goods transit, nor the rights or lives of railway servants, weighed much in the consideration of the companies in comparison to their primary mission, namely, to secure big dividends. It was these capitalist syndicates who made the Employers' Liability Act abortive by compelling their servants to contract out of it. When they found men working 16, 17, and 18, and in some cases 20 hours per day, not at long intervals, but often regularly, then it was surely right to ask Parliament to step in. It seemed to him (the speaker) that the sweating system was in operation on the railways in order to pay large dividends. They did not ask for an eight hours' day as a favour; they demanded it as a right, and they would not take it as a sop to stave off land reform. Referring to the Royal Commission on Sweating, he (the speaker) pointed out that the greatest offenders in this matter were too often found to be men clothed with authority, occupying responsible positions. After instancing some striking hardships of the system, he suggested the repeal of the 67th clause of the Factory Acts, and commented favourably on the idea of municipalities erecting workshops for certain occupations, to be let out to employers at a fair rate. This would, he contended, secure light, ventilation, and sanitary accommodation. It was, however, evident that Parliament could alone give the requisite power to curtail these abuses. But as long as they had the House of Commons filled with capitalists and landlords it was folly to expect drastric legislation. At the most moderate estimate it was absolutely essential for the welfare of the workers that no fewer than 30 labour members should be returned at the next Parliamentary election. They might advocate land reform, and a host of other admirable reforms, till the crack of doom without success, but if the trades unions would only second the vigilant action of the National Labour Electoral Association, political parties would hasten to carry out their desires. Thanks to that organisation, labour representation never looked so bright as it does to-day, both in local bodies and in Parliament. He warned them to exercise care in selecting the leaders of such a movement. They could have no reactionaries and tools of parties. Trades unions would never be the slave of parties. The question whether local government should be granted to this or that section of the State was but a fragment of labour representation, and those who advocate such government must beware lest in their zeal for party discipline they constitute themselves obstacles to the cause of labour. If they do, then they will most assuredly be swept aside and their cause demolished. After expressing sympathy with their ill-paid, ill-fed, and wretchedly-housed brethren, and a hope for their further success, he resumed his seat amid loud applause.

The usual vote of thanks was accorded the president for his address.

PHOTOGRAPHY OF LIGHTNING.

THE Council of the Royal Meteorological Society have issued a circular requesting that photographs of lightning may be sent to them. In response to a similar appeal last year about sixty photographs of lightning flashes were received from various parts of Europe and America. The council remind photographers, amateur and professional, that the photography of lightning does not present any particular difficulties. "If a rapid plate, and an ordinary rapid lens with full aperture, be left uncovered for a short time at night during a thunderstorm, flashes of lightning will, after development, be found in some cases to have impressed themselves upon the plate. The only difficulty is the uncertainty whether any particular flash will happen to have been in the field of view. A rapid single lens is much more suitable than a rapid doublet; and it is believed that films on paper would effectually prevent reflection from the back. The focus should be that for a distant object; and, if possible, some point of landscape should be included to give the position of the horizon. If the latter is impossible, then the top of the picture should be distinctly marked. Any additional information as to the time, direction in which the camera was pointed, and the state of the weather, would, the council state, be very desirable."

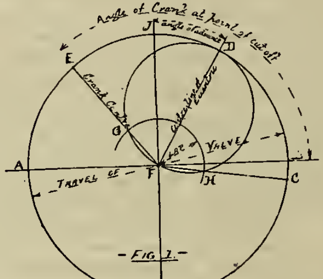
COLOUR-PRINTING FOR WALL PAPER.—Herr Hansenn, a Danish engineer, has patented a machine for the colour-printing of wall paper, which prints all the colours desired at one impression. Hitherto every colour has necessitated a separate journey through the press.

QUERIES AND REPLIES.

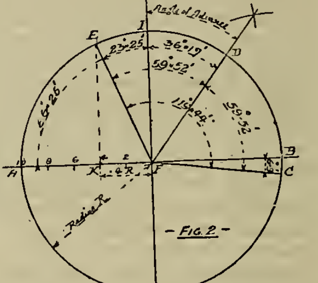
VALVE DIAGRAM.—Would "Omicron" or some other kind reader favour me with a solution of the following? In a steam engine the cut-off takes place at ·7 of the stroke, the angle of lead = 6 deg., width of steam port = $1\frac{1}{2}$in., and the steam port opens $\frac{3}{4}$ of its area. Find by Zeuner's diagram (neglecting obliquity) the travel of slide, the angle of advance, the outside lap, and the outside lead.—C. J.

Answer.—The above question I recognise as being the greater portion of one which was set in the "Honours" examination in "Steam" held by the Science and Art Department, South Kensington, in May last.

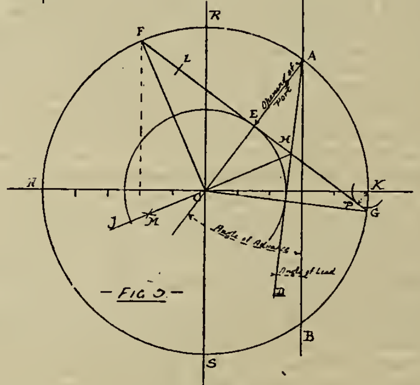
The following solution, shown in fig. 3, is, I venture to think, very simple in its construction, and one for which I can conscientiously claim originality. In the first place, it would have been as well if "C. J." had supplied us with the values of cos 66°25′ = ·4; and cos 59° 52′ = ·502, as these were given in connection with the question by the examiners of the department; for although they are not necessary for the *graphical* solution of the problem, yet we may find them of great service to us when solving the question *numerically*. However, I will endeavour to make the solution perfectly clear, for the sake of which I must first refer "C. J." to fig. 1, which illustrates the ordinary "Zeuner" diagram, where AB is line of valve travel, the circle AEDB representing the path of the *centre* of eccentric, FD is drawn in the direction of the *centre line* of eccentric; so that angle JFD is the angle of advance. The line FE—which is drawn from centre F through the point (G) of intersection of the arc GH and the circle FGDH—shows the direction of crank at point of cut-off, whilst, similarly, that drawn through the point of intersection H gives the position of crank at the point of steam admission or "lead." It will be clearly seen that the lines FE and FC, which, as before stated, give the positions of cut-off and admission respectively, make equal angles with line FD, representing the centre line of eccentric; so that if we *from the data given* set off the direction of the lines FE, FC (see fig. 2), and then bisect the angle EFC by the line FD, *we obtain* the direction of centre line of eccentric, and if at point F we erect the perpendicular FI, the anglo IFD equals *the angle of advance*, viz., 36° 17′. (This angle, when found either as above or by calculation, will be of use to us in fig. 3.)



- FIG. 1. -



- FIG. 2 -



- FIG. 3. -

Let us now proceed to check the result by a numerical solution. Referring again to fig. 2: From the data given, viz., cos 66° 25′=·4, and the point of cut-off taking place at ·7 of the stroke, and since it is very evident that FK=$\frac{4}{10}$ or ·4 of FA, and as FK is the cosine of the angle AFE, it may be safely taken for granted that the angle AFE is one of 66° 25′. Accepting this as true, the angle EFI will therefore be equal to 90°−66° 25′=23° 25′, and this added to the angle IFC (which equals 90°+ angle of lead = 96° 9′) gives as a result that the *whole angle* EFC = 119° 44′. Dividing this by two, we obtain 59° 52′ as the value of the angle EFD; subtracting from this the angle EFI = 23° 35′, we get as a final result that the angle of advance =36° 17′, which should agree with our *graphical solution* of the same (in fig. 2). Proceeding to calculate the amount of travel, lap, &c. necessary to fulfil the conditions, I must now state that the cosine of *half* the angle EFC will determine the lap in terms of *the radius* of valve circle, or in terms of the amount of "eccentricity" or "throw" of eccentric; that is, as cosine angle (EFD) 59° 52′=·502, the lap will therefore be ·502 of the radius of valve circle, and as the radius is equal in length to the opening of port *added to* the lap, that is, radius = opening of port + lap, therefore radius = opening of port + ·502 radius, or ·498 radius = opening of port; that is, radius = 2 × opening of port (very nearly), and *as* opening of port to steam = $\frac{3}{4}$ of $1\frac{1}{2}$ = $1\frac{1}{8}$, therefore *radius* of circle = 2 × $1\frac{1}{8}$ = $2\frac{1}{8}$, and it follows from this that *the travel of valve* = $4\frac{1}{4}$″ (very nearly) and *the lap* $1\frac{1}{16}$″.

Let us now proceed to solve the question *graphically*, by the aid of fig. 3, which, as I have above stated, I consider original. From point A on the vertical line AB draw the line AC so that it makes with AB an angle equal to the angle of advance, 36° 17′, found graphically as in fig. 2 or by calculation. On AC set off AE equal to given opening of port $1\frac{1}{16}$, and from A draw line AD so that angle DAB equals the *angle* of "admission," or "lead," 6° 9′. Perpendicular to the line CA and through point E draw the line FG, intersecting AD in H. Bisect the angle EHD by the line HM (obtained by marking off with the compasses distances HD = HL, and from these points drawing arcs of equal radii, intersecting at M and then joining MH). Then the point C, where the line HM intersects line AC, is the centre of the valve circle, whose radius is equal to CA.

With C as centre and CA as radius, describe the circle FAGN, join CF and CG. From K draw line KP perpendicular to line FG and RS perpendicular to line KN.

Then travel of slide equals KN = 4¼ inches
Angle of advance equals angle RCA = 36° 17′
Outside lap equals CE = $1\frac{1}{16}$ inch.
Outside lead equals KP = ·21 nearly.
Also, CF represents position of crank at cut-off
CG represents position of crank at admission.
CA represents position of eccentric.

I trust the above will meet all that "C. J." requires.—Omicron.

Cast-iron Gutters.—Can any reader tell me the technical name of the cast-iron gutters that connect the down pipe from the roof to the gutters along the pavement of a road?—H. L. Crate.

Answer.—These are generally known as "drop-spouts."—Azim.

Fixing Propeller Shaft.—I shall be greatly obliged if you or any reader of your paper will inform me of the best method, or the one mostly used on board ship, to retain the propeller shaft.—H. B. C.

Answer.—The propeller shaft is carried in a cast-iron pipe, a little shorter than the shaft. This stern tube, as it is called, is turned at its outer end, and fastened by a cone, or nut, to the stern frame. The inner end is fastened by a flange to the bulkhead at the end of the tunnel. The outer end is bushed, and lined with lignum vitæ, and at the inner end is a stuffing box. The shaft has brass sleeves shrunk on opposite the bush and stuffing box, the middle part of shaft being clear. The thrust block keeps the shaft from moving endways. The object of this stern tube, which in medium-sized steamers is twelve or fifteen feet long, is to bring the stuffing box into the wide part of the ship, where the engineers can get at it to pack it.—E. B., Swansea.

Sun-copying Drawings.—Can any reader oblige me with a recipe for sun-copying tracings, black lines on a white ground, similar to copies I have seen?—J. T.

Answer.—In reply to "J. T.," I am of opinion that he will not be able to find a process which will give either a *perfectly white* ground or lines which may be called a *thorough* black, at least that has been my experience up to the present period. There are in vogue at the present time two different methods of obtaining the wished-for result, viz.: (1) That in which the sensitised paper is so prepared that the print, after exposure, only requires washing in clean water, this sufficing to produce a line of a dark violet hue upon a slightly discoloured ground of a similar tint. This method is much simpler and, comparatively speaking, cheaper than the other "B. W." (black and white) methods, but is objectionable from the fact that the "developing" ingredient exists in a state of dust or a fine powder upon the surface of the "sensitising" coat, and, therefore, it may be easily rubbed off during the various manipulations necessary, and thus cause a smear or disfigurement on the resulting picture. From the fact of this developing coat overlying the sensitive one, it seems clear to me that a much longer exposure is necessary to obtain equal results with those of the other methods. One great reason for the comparative cheapness and simplicity of this method is that only one bath is necessary, and this only of ordinary material, such as zinc or wood, whereas in the other "B. W." processes *two* baths at least, and these also of a more expensive kind, must be employed. The patentee of this method, Mr. Shawcross, states in his patent specification that "The sensitive paper is prepared by covering it with two chemicals. The surface of the paper is covered with a solution of one of the chemicals, which is sensitive to light, the other chemical, which acts as the developer, is rubbed or pressed on the surface in the form of powder. For the sensitive solution a mixture of perchloride of iron with ferric salt, tartaric or citric acid, gelatine, gum, sugar, or other carbohydrate. Chloride of sodium or like salt is not absolutely necessary, but beneficial. For developing, powdered gallic or tannic acid, or substances containing these, such as catechu or powdered sulphocyanides, water or alcohol may be used as the developing solution."

(2) The other methods consist in coating the paper with the "sensitising" solution, carefully prepared; and, when exposed in the usual manner, the washing has first to take place in a "developing" *solution* contained in a guttapercha lined or porcelain bath, and, finally, a good washing in clean water completes the process.

The following is a recipe which I have found satisfactory in its results, but (and this for the benefit of those who may be desirous of taking up "one of the processes of sun photography in connection with engineering and other similar establishments") I must confess that for comfort, cleanliness, simplicity, speed of production, and last, but not least, cheapness, I must give my vote in favour of the "white line on blue ground" process, a description of which, together with particulars of apparatus required, was given in *The Practical Engineer* of May 6th, 1887, and of which method the writer has had a somewhat lengthy experience.

Recipe for Black Lines on White Ground.

The sensitising solution is prepared as follows: Dissolve *separately*—

(1) Gum arabic, 3 drms. Water, 17 ounces.
(2) Tartaric acid, 13 drms. Water, 6 ounces 6 drms.
(3) Persulphite of iron, 8 drms. Water, 6 ounces 6 drms.

Pour solution 3 into solution 2, well mix, and then pour the combined solutions 2 and 3 into solution 1, taking care to keep the mixture well stirred. Then add slowly, while stirring, 3 fluid ounces 3 drms. of liquid acid perchloride of iron, at 45° Baume. When the mixture is complete, filter through filter paper, and keep the filtrate in a bottle covered with ruby paper, away from the light.

Apply the above solution in a similar manner to that described in the "blue process" (*Practical Engineer*, May 6th, 1887), dry off quickly with moderate heat, and keep the paper thus coated in perfect darkness.

Expose the sensitised paper behind the tracing in the usual manner, in such a frame as illustrated in the before-mentioned article, and for a similar length of time, until the print shows out as a yellow drawing upon a white ground.

When the exposure is completed, float the print *upside down* in a developing bath, consisting of gallic acid (or tannin) 31 to 46 grains, oxalic acid 1¼ grains, water 34 ounces, until the yellow lines are converted into a violet black. When this occurs, *well* wash the print in clear water, and dry off as soon as convenient.
Omicron.

Coal Mining.—Will you, or any of your numerous readers, kindly answer me the following question? A single drift is ventilated by a brattice, 3ft. from one side and 6ft. from the other. Which side would you make the intake—(1) When the drift is rising, (2) when it is level, and (3) when it is dipping?—A Deputy.

Answer.—As a general rule make the drawing road the larger portion of the drift, and make it also the intake, if convenient to do so. If not required as a drawing road, make the return the largest in all cases; but in such a circumstance it would be better to make the sizes more equal.—H.

Transferring Plans.—I have a plan of a colliery, and wanted to extend the workings upon it, but the paper is too small for the workings which were intended to be plotted on it, and as the old plan is so dirty I am bound to make a new one from it. Will you, therefore, kindly inform me the best way to transfer this on to a piece of cartridge paper?—R. R.

Answer.—There are two methods of transferring a copy of a plan on to another sheet. 1. Make a paper tracing of the original plan, and place it upon the clean sheet. Secure it in position, and then carefully prick the plan through the tracing, taking care to use a fine needle and make small holes. The plan is then to be pencilled in from prick hole to prick hole, and afterwards finished in ink. 2. Make a tracing as before, and place it above a sheet of transferring paper on to the clean sheet. Then go carefully and strongly over all the lines of the tracing with a transferrer. The transferring paper can be bought at an architect's stationer's shop, or prepared by rubbing a sheet of tracing paper well over with moistened domestic blacklead, and a closed drawing pen may be used as a transferrer. The original will then be reproduced by the blacklead on the new sheet, and must be inked in, and finished as before.—H.

Book on Railway Switches and Crossings.—Can any reader of your practical and valuable paper inform me of the most modern edition on railway switches and crossings, with name of author, and cost?—W. L.

Artificer in the Navy.—Can any of your numerous readers afford me any information as to the steps required to become an artificer in the navy? Is it requisite to pass an examination? and is it necessary to enlist for any length of time? What is the rate of pay? If an examination has to be passed, what books is it desirable to study?—W. H. A.

Average Temperature.—Could you or any of your readers give me an average temperature of the weather from June 25th, 1886, to June 25th, 1887, and from June 25th, 1887, to the same date in 1888? You will see what I mean when I inform you that we have burnt over 200 tons of slack more this year than last, and we have no extra heating to do—less, if anything, than the year before.—Engineer.

Perrett's Patent Furnace.—Can any reader furnish me with the address of Perrett's patent furnace for burning small coal or "breeze?"—Stoker.

Helical Wheels.—Can any of my fellow-readers inform me of the best mode of setting out the teeth of a pair of bevel helical wheels, the larger wheel to be 34·8in. diameter, with 6in. face and 73 teeth, 1½in. pitch, and the smaller one or pinion 18·14in. diameter, with 6in. face and 38 teeth 1½in. pitch? Also a plain spur wheel 77·98in. diameter, with 140 teeth, 1¾in. pitch, to work in a pinion 40·1in. diameter, with 72 teeth. Any information with regard to making the patterns would oblige.—J. W. J.

Navy Electrician.—Could you or any of your numerous readers give me any information as to the requirements of electricians in the Navy, and how one who has a good knowledge, both practical and theoretical, of electric lighting may become one?—T. H.

Cement for Brass.—Will you or some of your numerous readers kindly give me a recipe for or the name of the best manufactured cement for brass? I want to attach brass rings to the outside of a brass cylinder by means of cement.—Marine.

Starting Gear.—A sketch and description of "Brown's steam and hydraulic starting gear" would be appreciated by S. B.

Portland Cement.—I should be glad if some reader would tell me the strength of Portland cement for beams, and also for fireproof floors. I should also be glad of a section of a fireproof floor capable of bearing a load of 3cwt. per foot, the floor having a span of 20ft. clear.—H. L. Crate.

Lift for Pump Clacks.—Will you oblige by giving the required lift for pump clacks or valves, and how to calculate the same in plain figures? Ex. 1.—For a 5in. ram pump, 2ft. 6in. stroke, running 30 revs. per min. Ex. 2.—For a 9½in. ram pump, 1ft. 9in. stroke, running 26 revs. per min.—Engine Attendant.

Finishing and Colouring Drawings.—In reference to the reply to a query on this subject in last week's issue, a correspondent writes to say he has found that if a weak solution—say one per cent.—of bichromate of potash be used for mixing Indian ink, the lines will, after an hour or two's exposure, become insoluble.—Ed.

Timber Tests.—I should be glad if you could give a very simple, reliable, and easily applied available test as to whether timber, especially oak, ash, deals, and elm, are thoroughly seasoned and ready for use—that is, in planking and cut up in cases, where it cannot be ascertained how long it has been cut down and sawn, &c.—Inquirer.

Pressure of Spiral Springs.—Could any of your readers give me a rule for calculating pressure spiral springs will stand when compressed to a given length, the full length, diameter, and section of wire being known? Rule wanted for round and square section steel.—G. B.

TO CORRESPONDENTS.

Strain on Crank Shaft.—In reply to "H. B.'s" communication, we beg to say that we hope shortly to give an article dealing with the subject which will assist you. We have not the space to enable us to go into your query to the extent you request at present.

H. Hartzig.—The cylindrical cistern you describe would have a capacity of 58 gallons. Almost any elementary pocket book of engineering formulæ would enable you to solve simple questions of this kind. We make no charge for giving such information. Our query column is freely open to all, and we are pleased whenever we can render any of our readers a service.

MISCELLANEA.

The Ebbw Vale Strike.—The 1,500 men who recently came out on strike at Ebbw Vale Coal and Iron Company have agreed to resume work pending a settlement of the terms of dispute.

The Lick Telescope.—Several important astronomical discoveries are announced in connection with the 36in. refracting telescope at the Lick Observatory. The Ring Nebula in the Constellation of Lyra has by its aid been resolved into a series of ovals of star clusters.

Proposed Technical School for Coatbridge.—It is proposed to erect a new school of science and art at Coatbridge, where the Gartsherrie Science School and West of Scotland Mining College has for many years been successfully conducted.

Milford as a Seaport.—The old idea of establishing Milford as a rival to Liverpool seems to have been revived. At the meeting of the Milford Docks Company last week, the chairman stated that he had seen the prospectus of a company which was being formed for the purpose of running steamers between Milford and New York in five days.

Small Screws.—The smallest steel screws in the world are made in a watch factory. The fourth jewel-wheel screw is the next thing to being invisible, and to the naked eye it looks like dust. With a glass it is seen to be a small screw with 260 threads to the inch, and with a very fine glass the threads may be seen very clearly. These little screws are $\frac{4}{1000}$ of an inch in diameter, and the heads are double the size. It is estimated that an ordinary lady's thimble would hold 100,000 of these tiny little screws.

The Pipe Line of the Liverpool Waterworks.—An important and delicate portion of the works in Cheshire in connection with this gigantic undertaking is now in hand at Beeston Station. Here the pipe line has to be carried under the main line of the North-Western, and also under the Shropshire Union Canal and the river Gowy, which run parallel with the railway. Just at this point there is immediately beneath the surface an enormous bed of quicksand, which renders the work much more difficult and costly. The water in the Shropshire Union Canal has been drawn off, and all traffic stopped, the Liverpool Corporation paying, it is said, a sum of £100 a day in compensation. A double line of pipes is being laid under the canal to to prevent the cost of drawing away the canal water on a future occasion.

A New Coal-heading Machine.—The Chesterfield and Midland Counties Institution of Engineers had an excursion on the 30th ult. to Messrs. Stanley's collieries, Nuneaton, to inspect a new coal-heading machine, which has recently been invented by Mr. Stanley, and which was to be seen at work both on the bank and in the mine. Before its invention roadways and headings had been made by means of manual labour, assisted by blasting, but this machine is made to cut an annular grove around the face of the heading, leaving a core which either falls or is got off as the work proceeds. It is said the machine can cut a heading in about one-fourth of the time which would be occupied if the work were done by hand labour, and that it will cut through the hardest material, such as thin bands of ironstone, without difficulty.

Soapstone in Burmah.—The native Extra Assistant Commissioner at An, in the Kyoukphu district, has, according to the *Indian Engineer*, furnished an interesting account of the soapstone mines at the Myingude mountain in the Yoma Range, and on a small hill adjoining the Myingude mountain. The soapstones are found between other stones, and it is difficult to ascertain the exact yield of the mines, but last year some Burmese from Upper Burmah dug eight mines and obtained about 5,000 viss. The value of the stone is said to be, on the spot, from 70 to 80 rupees per 100 viss for the first quality, and from 50 to 60 rupees for the second quality. The greatest depth dug last year was about eight cubits, but the hill is said to be covered with soapstones, and the production of them will entirely depend on the amount of labour employed.

Wrought-iron Belting.—Mr. John Spiers, of Worcester, Mass., gives the following interesting particulars of the successful adoption of wrought-iron belting: "A lathe used for turning rolling mill rolls, compound gear, has a 48in. pulley. This is driven by an 18in. pulley on the countershaft, which makes 120 revolutions per minute, and is 8ft. from the 48in. pulley, measured from centre to centre; both pulleys are of iron smoothly turned on the faces. A 7in. double leather belt was used in these pulleys, but would slip when the turning tool became dull. This belt was replaced by one made of Russian sheet iron, the same as that used for stove pipes and parlour stoves, and was riveted together in the ordinary way. It was 7in. wide and 2in. longer than the leather belt, the extra length making up for the want of elasticity in the iron. During one year's steady run this iron belt could not be slipped, even when a heavy cut on a 25in. roll was taken, which broke a Sanderson steel tool, having a section of 12in. by 2½in., a cutting surface of 2½in., a feed of ⅛in. per revolution, and an overhang of 4in.

SELECTED PATENTS.

APPLICATIONS FOR LETTERS PATENT.

August 24th.

12194 Lever Spring Winch, T. Stanley, Beighton.
12198 Electrical Switches, F. T. Schmidt, Keighley.
12199 Card-covered Rollers, B. F. Byrom, Manchester.
12202 Apparatus for Obtaining Metals from Ores, J. B. Hannay and R. Tervet, Glasgow.
12206 Adjustable Spanner, J. Widkless, Birmingham.
12212 Middlings Purifiers, C. J. Robinson and J. Ward, Liverpool.
12214 Tool for Removing Hard Scale from Steam Boilers, W. G. Akhurst, Gateshead-on-Tyne.
12221 Picks, J. C. Bell, Sheffield.
12223 Crushing Ores, O. Bilharz, jun., Manchester. (O. Bilharz, sen., Germany.)
12226 Reversing Steam Engines, C. L. Reade, Chancery Lane.
12228 Cutting of Wood Shavings, J. S. Dunn, Glasgow.
12230 Iron Chairs, A. M. Gjestvang, London.—[Complete Specification.]
12231 Taps and Faucets, M. Anthony, London.—[Complete Specification.]
12232 Steam Generators, H. H. Lake, London. (G. P. Erhard, United States.)
12233 Armour Plates, M. A. Howell, Holborn.
12234 Heating and Cooling Bakers' Ovens, J. Adair, Waterford.
12238 Propelling Boats, R. Werner, London.—[Complete Specification.]
12239 Blowing Coal and Other Minerals, T. Bower, R. W. Bower, and J. Blackburn, Middlesex.—[Complete Specification.]
12240 Chains, C. Lock, London.
12245 Tricycle Railway, H. M. Barron, London.

August 25th.

12255 Air Fans, H. T. Johnson and T. S. Wilson, Manchester.
12256 Hydraulic Cranes, A. B. Brown, Glasgow.
12257 Fire-extinguishing Apparatus, H. Bains, Guildhall.
12259 Reversing Mechanism for Burl-dyeing Machines, J. D. Asquith, Yorkshire.
12261 Tappet Motion, J. T. Whittaker, Farnworth.
12262 Blow Pipes, J. F. Duke and W. Macpherson, Manchester.
12264 Metallic Surfaces Electro Deposits, F. E. Elmore and A. S. Elmore, Cockermouth.
12273 Stopping Leakage in Pipes, J. Lawrence, London.
12274 Paper-cutting Machines, W. Fuller, London.
12279 Printing Presses or Machines, J. Jordan and E. Howard, Pentonville.
12280 Governors, J. S. Raworth, London.
12281 Charging Gas Retorts, J. Cunningham, London.
12285 Wire Ropes or Bands, A. Latch and T. C. Batchelor, London.—[Complete Specification.]
12288 Steam Engines, R. H. Flower and G. Achilles, London.
12292 Moulds for Steel Castings, G. Allen and T. Turner, Middlesex.
12296 Straight Edge Protractors, G. C. Lilley, London.

August 27th.

12299 Gig Mills, E. Michaelis and A. Smethurst, both of the firm of A. Smethurst and Co., and C. Wood, Manchester.
12302 Friction Gearing, H. W. Houlden, Doncaster.
12304 Combined Thrashing, Dressing, and Finishing Machines, W. G. Smalley, sen., and W. G. Smalley, jun., Leigh.
12311 Machines for Cigarettes, E. de Pass, London. (The firm of A. Bauer and Co., Switzerland.
12312 Gearing Elliptical Pistons, C. A. Winder, Sheffield.
12317 Steam Boilers and Engines, Flurscheim and Bergmann, trading as Eisenwerke Gaggenau, Chancery Lane.
12318 Gas and Air Reversing Valves, J. Jardine and J. Ferguson, Glasgow.
12324 Feed Mechanism, A. P. Gibson, London.—[Complete Specification.]
12327 Refrigerating Machines, W. Garden, Middlesex.
12331 Tubular Steam Generators, A. de Dion, T. G. Bouton, and C. A. Trépardoux, London.
12332 Electric Meters, J. Cauderay, Chancery Lane.
12335 Attachment to Oil Cans, R. Bufford and J. T. Walker, London.
12343 Aluminium, B. J. B. Mills, Middlesex. (J. D. Bennett, United States.)—[Complete Specification.]

August 28th.

12347 Pick and Socket, S. Willington and E. Smout, Sheffield.
12353 Drill Braces, G. R. Postlethwaite, Birmingham.
12355 Paper Cutters, L. Ehrlich, London.—[Complete Specification.]
12357 Centrifugal Apparatus, R. A. Robertson, of the firm of Mirrlees, Watson, and Co., Glasgow.
12359 Looms, C. Catlow, Halifax.
12360 Internal Combustion Thermo-motors, J. Hargreaves, Liverpool.
12365 Looms, J. Richardson, trading as Richardson, Tuer, and Co., Manchester.
12366 Multiple Wood Engraving Machine, F. East, Dundee.
12374 Condensing Steam, E. F. Piers, Manchester.
12380 Straightening Shafts, W. A. McCool, London.—[Complete Specification.]
12381 Firegrates, H. H. Lake, London. (G. L. Kitson, J. Reagan, and S. L. Smalls, United States.)—[Complete Specification.]
12399 Gas Motors, L. Charon, Middlesex.—[Complete Specification.]
12401 Iron and Steel, B. A. W. S. van Oldrintenborgh and O. N. Orban, London.—[Complete Specification.]
12405 Spinning Machinery, P. Heilmann-Ducommun and V. Steinlen, trading as La Société Heilmann-Ducommun et Steinlen, London.
12414 Perpetual Calendars, H. H. Lake, London. (Messrs. Writh and Co., Agents of E. Ph. Hinkel, Germany.)

August 29th.

12441 Ribbed Plates for Steam Boilers, J. Lea, London.
12452 Electrical Locomotives, A. Sandron, Middlesex.
12453 Hardening and Tempering by Electricity, W. P. Thompson, Liverpool. (P. Diehl, United States.)—[Complete Specification.]
12465 Screw Wrenches, S. Mura, London.

August 30th.

12471 Governing the Speed of Gas Engines, H. Williams, Manchester.
12472 Gas Motor Engines, H. Williams, Manchester.
12476 Multiple Expansion Steam Engines, J. Turnbull, Glasgow.
12486 Winch Handles, J. Bradbury, Manchester.
12495 Baling Presses, J. E. S. Perkins, Peterborough.
12500 Metallic Tubes, J. Russell and Co. (Limited), and A. W. Hutton, Middlesex.
12501 Portable Drilling Machines, J. Bradbury, sen., and J. Bradbury, jun., London.
12514 Railway Carriages, M. H. Smith and L. L. T. Bateman, Middlesex.
12517 Boiler-feeding Apparatus, E. W. Jones and H. Cutting, London.

PUBLISHERS' ANNOUNCEMENTS.

BACK NUMBERS of "The Practical Engineer," from the commencement, can be obtained at either of our offices in London or Manchester, or by order of any Newsagent.

Vol. I. (bound), containing Nos. 1 to 44 inclusive, from March to December, 1887, price 6s. 6d., can still be obtained by order from any Newsagent, or will be forwarded, carriage paid, from either of our offices on receipt of the amount by postal order or stamps.

Numerous complaints having been made to us by Subscribers of the difficulty they experience in obtaining copies of the *Practical Engineer* in certain districts, we have to state that the Journal can be obtained by any Newsagent through the ordinary trade channels, and no difficulty should therefore exist in obtaining copies by order of any Newsagent.

For the information of the trade, we may state that copies can be obtained from either of our Offices in London or Manchester, or from any of the following wholesale houses.

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&c., &c., &c.

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EDITORIAL NOTICES.

All communications for the Editor of this Journal should be addressed to 6, Victoria Station Approach, Manchester.

Communications intended for insertion in the current week's issue should reach us not later than Tuesday Evening.

We cannot undertake to return rejected manuscripts or drawings unless accompanied by a stamped and directed envelope.

Contributors are requested to write on one side only of the paper. Sketches should be sent on separate sheets.

TO ADVERTISERS.

Advertisements intended for insertion in the current issue should reach us on Wednesday morning at the latest.

THE
PRACTICAL ENGINEER.
SEPTEMBER 14TH, 1888.

STRAINS IN CANTILEVER BRIDGES.

ADVICES from India inform us that certain movements have been noticed in the Hooghly Bridge, which have led to the application of certain tests to ascertain their importance and tendency. The Hooghly Bridge comprises three main parts, viz., a central double cantilever, 360ft. long, carried upon two river piers, 120ft. 6in. apart from centre to centre, and two side spans of 420ft. each, making a total length of 1,200ft. In point of principle, the cantilever bridge and the continuous girder bridge are the same when the load is such that the points of contra-flexure fall at the junctions of the cantilevers with the free spans, but during the passage of a load the positions of the points of contra-flexure are always varying, and it is only while the loads on each side of the cantilever are symmetrical that it will remain steady on its bearings. A load passing over the bridge in one direction, unbalanced by one coming in the opposite direction, must tend to depress first one and then the other end of the central cantilever, and thus whenever a train passes over the bridge its central member must rock, and the greater the moving load in proportion to the weight of the structure the more evident will be the effect in this direction.

The total weight of the cantilevers may be taken at 1,500 tons. Let us see how it will be affected by a full load on one of the side spans. The central cantilevers may with sufficient accuracy be regarded as projecting 120ft. from the river piers. Taking the live load on the side span at the moderate amount of one ton per foot run per line of railway, the total load will be 840 tons, of which 420 will rest upon the cantilever, giving a moment of 420 × 120 = 50,400 foot-tons about the centre of the nearest river pier. The effect of this moment of force will be to relieve the river pier farthest from the live load of some part of the load it was previously supporting at the expense of the nearest pier. The distance of the piers being 120ft., the load thus removed will be 50,400 ÷ 120 = 420 tons. The total load on each river pier due to the dead load of the structure is 1,000 tons for the side span and 750 tons for half of the double cantilever, 1,750 tons in all. The 420 tons taken from the one pier passes to the other, and it has this to support in addition to the 420 tons of live load already imposed upon it; hence the loads on the piers will be respectively 1,750 – 420 = 1,330 tons, and 1,750 + 420 + 420 = 2,590 tons, a variation of considerable magnitude when the rapidity with which such change of load occurs under passing trains is remembered. The greatest variation will occur, however, if it should happen that both lines, from one land abutment to the centre of the nearest river pier, are loaded; we should then have a further load of 120 tons shifted from one pier to the other, thus making the loads 1,210 tons and 2,710 tons. This variation of load is not sufficient to actually disturb the stability of the cantilevers upon their bearing, but is certainly enough to cause a great deal of vibration, and as the double cantilever is carried upon steel pedestals 30ft. high, the vibration will be more pronounced than if the piers were entirely of masonry.

In a bridge with continuous girders passing over one pier, and supported upon a suitable rocking bed, there would not exist that sort of concussion which must result from the sudden interchange of loads on two contiguous piers; the load would vary on the pier, but the variation of the position of the points of contra-flexure on either side would render the change more gradual.

The rocking tendency referred to in the foregoing observations must, to a greater or less degree, occur in all cantilever bridges in which double cantilevers occur; and in those in which the cantilevers are carried on single piers it will be evidenced by transferring a portion of the load from the front to the back of the pier, and *vice versâ*. A rocking bed plate cannot be used in connection with a cantilever bridge, as from its construction the moments of stress cannot equalise themselves over the pier, as in a continuous girder.

THE BRITISH ASSOCIATION.—SIR FREDERICK BRAMWELL'S ADDRESS.

Although not marked by the breadth which characterised that of the previous engineer-president, Sir John Hawkshaw, in 1875; nor by the daring originality of Prof. Tyndall's, at the Belfast meeting of 1874; nor leading us into the fairy land of research, as did Sir Henry Roscoe, at Manchester last year, we feel that Sir Frederick Bramwell has struck a chord which will find a response in many a breast, and for this he deserves our warmest thanks. His text was not the great leading principles, but the value of little things—of the "next-to-nothings," of minute details—a lesson which eager and impatient workers are too often apt to forget. Concurrently with the exposition of this, he gave the "praise song" of the engineer, terminating it in a peroration claiming for his work and its results the inspiration and the beauty of true poetry—something which is not of the earth, earthy. Though the illustrious president has told us nothing which we did not know before, but as far as facts were concerned has simply summarised the work and triumphs of the engineer, ranging from steam and gas engines to electric lighting; from bicycles to great guns; from iron and steel to sanitation, and so forth—he at least has given us lessons well worth pondering over. We should not only set the highest value on the "next-to-nothings," but we should magnify our work and redeem it from the charge of being ultra-mechanical, to the exclusion of its broader and grander aspects. Herein lies the gist of this eloquent lay sermon. It is from this higher standpoint, apart from that of mere cheapness of production, that the introduction and improvement of prime movers as a substitute for unintelligent manual labour is seen to be a great aid to civilisation—to the raising of humanity. To be relieved from unintelligent toil is the yearning desire of myriads of workers. The divorcement of hand and brain is necessarily an evil. Hence those discoveries which tend to wed the subtle brain and lissom fingers are a clear and blessed gain to humanity. Pure science and science applied are no longer antagonistic, but one aids and advances the other, and both tend to the common weal of the race. We wish, however, that Sir Frederick could have found some words of comfort for the millions of toilers whose labours, by reason of the introduction of mechanism, have become even more automatic than they might have been without such introduction. There are myriads of such who, through their nine hours, more or less, of daily labour, continued year by year, direct only a single simple operation or set of operations of their machines, work involving so small a modicum of intelligence that the workers become nearly as automatic as their machines. Would that some of the poetry of science might be infused into those dull and cheerless lives! A knowledge of the marvels of the teeming universe should be brought well within the reach of these patient operatives, to whom our country owes so much, and the dulness of their lives relieved with a broad and generous culture. Here is a field in which many of our leaders may do good work if they will take to heart the passage from Sir Thomas Browne, quoted by the president: "I make not, therefore, my head a grave, but a treasure of knowledge, and study not for mine own sake only, but for those who study not for themselves."

THE FIRST CENTURY OF THE MARINE ENGINE.—IV.

(Continued from page 425.)

In the single-cylinder engine, with even moderate steam pressure and expansion, a considerable amount of steam is condensed, not only on account of the mechanical work which is done, but chiefly through the action of the sides of the cylinder. During expansion, heat is restored to the condensed steam, and the film of water re-evaporates either partially or wholly. With low rates of expansion, the temperature of the internal surface of the cylinder is higher than the exhaust temperature; while with high rates the temperature during expansion is so much reduced that when fresh steam enters at the beginning of the next stroke a large quantity is condensed. This is not all re-evaporated during expansion, and on the communication to the condenser being opened at the end of the stroke it is suddenly evaporated, and passes into the condenser without doing useful work, a cause of loss of efficiency which increases with the pressure and ratio of expansion. Hence arose the necessity for compound engines.

Messrs. Randolph and Elder took up the receiver type of engine at an early period of its history, and from about 1868 a very rapid increase in the number of compound engines took place, so that in a very few years they became almost universal in the mercantile marine. A considerable improvement also took place in their efficiency. Steam pressures went up to 80lb., and in some cases to over 100lb., on the square inch; but it was soon found that at the higher pressures a recurrence of the evils of single engines took place.

This led to triple-expansion engines, in which the steam is expanded successively in at least three separate cylinders, and such engines form the most important development in marine engineering which has taken place during the past few years. Generally speaking, steam of a boiler pressure of about 150lb. on the square inch is employed. Being admitted into the first, or high-pressure, cylinder, it is cut off at about three-fourths of the stroke and allowed to expand; it then passes into the mean-pressure, or middle, cylinder, and there expands as in the low-pressure cylinder of an ordinary compound engine; and from that it passes into a third cylinder of much greater capacity, where it is still further expanded; and, lastly, it escapes into the condenser. Such is the most common arrangement, but many triple-expansion engines have four cylinders, the final expansion taking place in two cylinders simultaneously, instead of in one larger low-pressure cylinder; and many other arrangements have been proposed, and in some cases carried out, but into the consideration of these we need not enter. The general principle is that in the triple-expansion engine the fall of temperature is divided between at least three cylinders, and the amount of condensation in each is reduced, and what does take place is to a large extent utilised during re-evaporation behind the pistons of the mean and low pressure cylinders. A saving of from 25 to 30 per cent of fuel, as compared with ordinary compound engines, was the result of the introduction of those with triple expansion.

As the compound engine required to be compounded when pressures increased, so with pressures higher than those used in the triple-expansion engine, quadruple or even higher expansion engines may become necessary. But it must be remembered that the rate of increase of temperature of saturated steam decreases as the pressure increases; and as the cost of construction of engines increases with the pressure, a point must soon be reached when the increase of efficiency of the steam will be balanced by the increase of cost, and by the loss of efficiency of the mechanism from increased friction—in other words, when the theoretical increase of efficiency will be balanced by practical losses. This point can only be determined by practical experience.

It will thus be seen that triple and quadruple expansion engines are the natural developments of the ordinary compound engine, and as at present constructed have been evolved from the practice of many engineers, and I shall not attempt to apportion credit to all who have a claim to it. There are, however, a few names especially connected with the Clyde which will at once occur to everyone as deserving special recognition, and I think the first place will be unanimously given to Dr. A. C. Kirk, as the man who made triple-expansion marine engines a commercial success. In 1874, when connected with the firm of John Elder and Co., he designed the engines of the Propontis. In these engines a pressure of 150lb. on the square inch was employed. They had three cylinders of progressive capacities, and each was placed above its own crank in a three-throw crank shaft. The boiler employed was of the water-tube type, and gave so much trouble that it was taken out and replaced by an ordinary internally-fired boiler carrying a pressure of 90lb. on the square inch. The original engines of the Propontis are still at work. For some years after the above date little progress was made in the increase of steam pressure and the construction of triple-expansion engines, the few that were made being of small size, and the ordinary compound engine practically held the field till 1881, when Mr. Kirk, as senior partner of Messrs. Napier and Sons, designed and constructed the engines of the Aberdeen, which he has described* before this institution, and of which the following are the chief particulars. They are essentially of the same design as those of the Propontis, the cylinders being 30in., 45in., and 70in., by 4ft. 6in. stroke. The boilers, two in number, are ordinary double-ended boilers, constructed entirely of steel, with six of Fox's corrugated furnaces in each, and the pressure is 125lb. on the square inch. There is no superheater. The high-pressure cylinder is not jacketed, the second is jacketed with steam of 50lb. pressure, and the low-pressure one with steam of 15lb. above the atmosphere. When the ship was complete 2,000 tons of dead weight were put on board, and the engines tested on a six hours' run at 1,800 H.P., and the consumption of coal was found to be a little over 1¼lb. per I.H.P.

The Aberdeen proving most successful gave a great impulse to the making of triple-expansion engines, and the great majority of the engines of the larger sizes built for the merchant service during the last six or seven years have been of this type. It is not necessary that I should enter into particulars of these, as Mr. Parker's paper, published in the last year's volume of the Transactions of this Institution, will supply all the information which may be wanted, as no great change has taken place in the interval. A considerable number of triple-expansion engines have been built for the British and foreign navies. The largest set of 13,000 I.H.P., built by R. Napier and Sons, was for the Russian navy. This and the further fact that the Società Hawthorn-Guppy, Naples, are constructing triple-expansion engines for the Royal Italian twin-screw armour-clad Sardegna, of an aggregate power of 25,000 I.H.P., the largest power hitherto put into any vessel, are matters for grave consideration by those who are responsible for our national defence.

With steam pressure above 150lb. on the square inch quadruple-expansion engines have been designed. Mr. Walter Brook, of Messrs. Denny, Dumbarton, has taken the most prominent part in their introduction, and has displayed great ingenuity in their design. A form of quadruple-expansion engines has recently been designed by Mr. Ferguson, of Fleming and Ferguson, Paisley, in which the cylinders are not arranged either all in line, or by twos in the same vertical plane, but are grouped together all at the same height above the crank shaft. The design seems very compact, but an opinion about the real value can only be given after we know something about the efficiency of the mechanism. Ordinary compound engines with two cylinders have been converted into triple and quadruple expansion engines in various ways, which have been discussed before this institution.

The term "efficiency" should be understood in a much wider sense than that in which it is generally used, and should not simply be confined to the consideration of the consumption of fuel in a limited time, and to what may be largely an artificial measure of power. The shipowner should measure the efficiency of his ships by the ratio of the actual earnings in a given time to that part of the capital which is chargeable to that time; and this latter item includes not only share of first cost and daily expenses, but also of repairs and probable renewal, for an apparent economy may be bought too dearly. In this connection, and also in connection with the development of marine engines, it is only right to mention that Mr. Holt, an extensive shipowner, has stated that, in his opinion, mere economy of fuel is not much cared for now; coals, which used to be the greatest, are becoming one of the minor disbursements of a steamer; and he believes that the compound engine will come to be abandoned. He has, moreover, the courage of his opinions, and has built single-crank engines of considerable size, which are said to give very good results. For large sizes, however, there are very obvious objections to such designs; and until more information has been given regarding their actual working, it is impossible to compare them with those which are more commonly used.

The use of the steam jacket both in land and marine engines has not always been accompanied by clear notions of its action on the part of engineers. It was originally designed by Watt; and whatever he may have thought about it, mistaken ideas were held regarding it by his immediate successors, who thinking that it only served to prevent radiation from the external surface of the cylinder, reasoning, as they did, from the caloric hypothesis, as the jacket presented a greater surface than the cylinder inferred that it was not only unnecessary, but wasteful, and its use was to a large extent abandoned in land engines, and entirely in marine engines. It was reintroduced into the latter by John Elder, and with the design he used he was able to prevent a considerable amount of condensation, and thus, as we have seen, improve the efficiency of the steam. But, contradictory as it may seem, the use of the steam jacket (as ordinarily constructed) is a violation of the fundamental law of maximum efficiency of heat engines, which requires that they should receive all their heat at the maximum, and give it out at the minimum temperature. In an engine with a steam jacket some of it is received at temperatures between these, and at times when the heat imported lessens the efficiency, as it evidently must do at and near the end of the stroke of a single engine, or of the low-pressure cylinder of a compound engine. The steam jacket must thus be looked upon as a necessary evil, justified only by the physical properties of the steam, and of the materials hitherto used in the construction of engines; and unless the conditions under which the steam is used be carefully studied, and the jacket judiciously designed and carefully kept in order, it may be a cause of loss. For it can be shown that while the jacket increases the work done by the expanding steam, the increase is by no means so great as it would be if the heat employed in the jacket steam had been applied to generate more steam for use in the cylinder. Moreover, it is extremely doubtful if at sea steam jackets receive the attention they require to make them efficient. Hence, in multiple-expansion engines, in which the variation of temperature is not very great, steam jackets have either been wholly or partially omitted.

The early forms of marine boilers were designed not so much with regard to strength, as with the object of the greatest possible storage. They were simply large rectangular tanks, with fireplaces and flues, all with flat sides, and the opinion was expressed by some of the makers that "the most convenient form of boiler is that it should be adapted to the form of the boat, and that being taken for granted, the safety would depend on the strength of the metal, and not upon the form." Watt had discouraged the use of high-pressure steam, and public prejudice had no doubt been raised against it by accounts of explosions in American river steamers, which were much commented on in the British press. Several unfortunate explosions in this country of boilers of special design heightened the feeling, as the public were not in a position to distinguish what was due to faulty construction or careless working. The salting up of the boilers was another difficulty in the way of their development, but still the attempts of Messrs. Hall, of Dartford, in 1838, to get rid of it by means of surface condensation were not appreciated by engineers, and consequently the use of the surface condenser did not become general for many years after the above-mentioned date. As steam pressures rose to 20lb. or 30lb. on the square inch the boiler was strengthened by stays, and instead of flat flues, tubes were used to supply the necessary heating surface, and boilers of this type remained in use until the compound engine with surface condensation became common. Then, with pressures of from 60lb. to 90lb. on the square inch, it became necessary to use some form of cylindrical boiler, of which there is a considerable number of modifications. Those used in the mercantile marine may be divided into two classes—(1) single-ended or single-fired boilers, (2) double-ended or double-fired boilers; and such simple designs have been found preferable to the many special forms which have from time to time been proposed. The locomotive form of boiler is much used in steam launches of the mercantile marine, and in torpedo boats and launches in the navy, and in a few cases in larger ships. In all essential details the steam boiler is almost exactly the same as when compound engines became general, except in the matter of strength, as we have now the command of improved materials and appliances. Steel is now almost exclusively used in the construction of their shells, and this in special forms, as for instance in Fox's corrugated furnaces, has enabled them to be safely worked up to pressures of 200lb. on the square inch. On the future of the marine engine Dr. Kirk has remarked "that it is the boiler that bars immediate progress. The only part of the boiler that does bar immediate progress is the furnace, because as to the rest of the boiler, the boiler shell, the tubes, and the stays, we can get over all difficulties, but the furnace is the weakest part of the boiler, and anything further that can be done in the direction of a simple and strong furnace would be a very great benefit;" but he further remarks in the same way as I have already pointed out, "that there must come a stop to this increase of pressure, not but that you will get economy as you go up in pressure, but at each step that economy will be smaller and smaller, while the cost of machinery will increase, and we have not only to look at the mechanical reasons, but we have also to look at the commercial ones." It is improbable, for reasons connected with both the engines and boilers, that there will be any further great increase of steam pressure, unless there is a radical change in one or other, or possibly both of these.

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*Trans. Inst. N. A., vol. xxiii., p. 34.

(To be continued.)

LESSONS IN MECHANICAL DRAWING.—XXI.

By Prof. A. MacLay, B.Sc., C.E.

The student should now be able of himself to find his way through a number of problems on loci, with a little assistance from notes added to them.

Those which follow are classified, not as to the manner in which they are derived, but according to result. In this way, while they form good exercises in drawing, in that they require neat and skilful working in order to obtain correct results, at the same time many of them are useful as methods of constructing certain curves and figures, and to this attention is also directed. More important, perhaps than either of these considerations, is the training in giving a graphical representation of geometrical conditions.

A word or two may be helpful here as to the meaning of the terms used in the heading below. In Lesson XII. a locus was referred to in one place as the curve corresponding to an equation; in another as the path of a point moving on the paper according to certain conditions. The student will now be in a position to understand the general definition of the term. It is given by a modern writer* as follows: "When a point is restricted by conditions of any kind to occupy any of a particular series of positions, that series of positions is called the locus of the point."

The term "point path" may be used to distinguish those loci which may be conceived of as being the result of mechanical movements of any kind from those which are derived from purely mathematical or geometrical considerations. For example, to an ellipse, as a curve traced through points which all lie in the same relation as to distance from a given fixed point and straight line; or, as the graphic representation of the equation $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$, we would apply the name *geometrical locus*. But to an ellipse as described by means of a string tied to the foci; by the conicograph, or by the elliptic trammel; or lastly, by a point on the connecting rod of a steam engine, we may more aptly apply the term *point path*.

Another term, which has been used in the course of these lessons, in referring to a certain class of curves, viz., *Conic Sections*, will only be fully understood when we come in a later lesson to treat of sections of solids. Meantime it may be briefly explained—(1) That a cone is the solid swept out in space, or *generated* by the rotation of a right-angled triangle about one of the sides containing the right angle as axis. The hypotenuse (the side opposite the right angle) generates the conical surface, and the third side, the plane of the base which is a circle. (2) That if this cone be cut by a plane—

(*a*) perpendicular to the axis, the intersection is a circle;
(*b*) parallel to the axis, an hyperbola;
(*c*) parallel to a generating line (*i.e.*, to any position of the hypotenuse of the generating triangle), a parabola;
(*d*) by any plane intermediate in position between *a* and *c*, an ellipse.

The student may verify these statements in a simple manner by forming a model of a cone out of soap and cutting it up in the various ways indicated.

It should further be noticed that a point, a straight line, and a triangle may also be included as conic sections, for in case *a*, if the cutting plane passes through the apex, the section is then a point; in *b*, if the plane passes through the axis, the section is a triangle; and in *c*, if the plane passes through a generating line, the section is a straight line.

Exercises on Geometrical Loci and Point Paths.

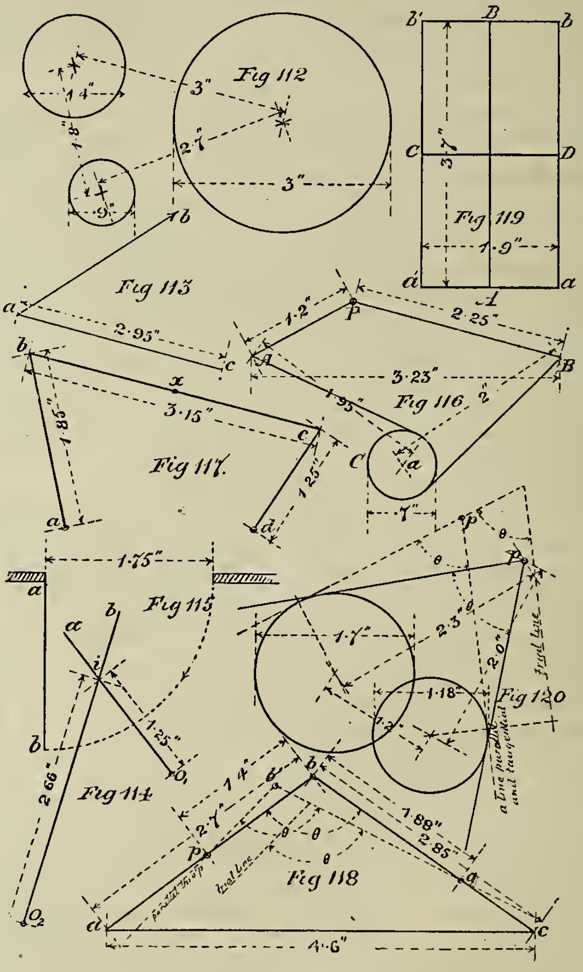
Linear.

Ex. 95.—Draw two lines *ao*, *bo*, intersecting at *o*, and including an angle of 40 deg. Determine a point $2\frac{1}{4}$in. from *o*, and such that its distances from *ao* and *bo* are as 2 : 3. (1884.)†

Ex. 96.—If from a given point any two lines be drawn, cutting two given lines, show by construction that the locus of the intersection of the diagonals of quadrilateral figures so formed is a straight line.

Ex. 97, Fig. 124.—RQ and CP are two links jointed at P. C is a fixed centre. Q is constrained to move in the line CQ. Show the path of R while P describes a circle about C.

Ex. 98, Fig. 119.—A line AB moves backwards and forwards at a uniform rate from *ab* to a^1b^1; CD moves also uniformly from aa^1 to bb^1. While CD moves from a^1a to b^1b, AB moves from *ab* to a^1b^1 and back. Draw the curve traced by the intersection of AB and CD. (1883.)



Circular.

Ex. 99.—Two circles of 1·8in. and 2·7in. diameter have centres 2·6in. apart. Two rods, *ao*, *bo*, 2·3in. and 3·2in. long, jointed at *o*, are tangents to the circles respectively, touching them at the extremities *ab*. Draw the rods in all possible positions. (1886.)

The point *o* will be the intersection of the point paths of the extremities of the tangents, supposing each of the latter to be rigidly attached to its circle and swung round its centre. The paths are circles, and intersect at two points, from each of which two tangents can be drawn to each circle.

Ex. 100.—Find the point path of the corner of a carpenter's square, of which the sides are 1ft. long, when made to slide, corner down, between two pins placed horizontally and 9in. apart.

See Euc. III. 21 and 31.—The above is a practical means of testing the circularity of hollow cylinders. It is also the principle upon which the core-box plane is constructed—a tool used by pattern makers for planing semi-circular grooves out of the solid.

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* Eagles' Const. Geom. of Plane Curves, p. 29.

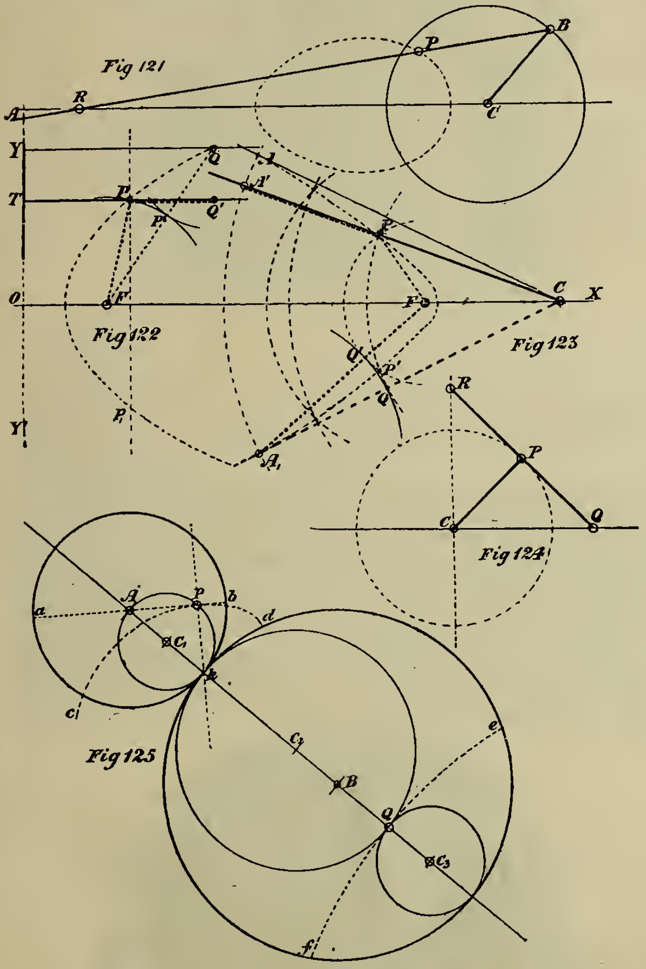
† Those questions with years appended are from the Science and Art Department Examination Papers in Subject I.

Ex. 101, Fig. 118.—The triangle *abc* moves so that the sides *ab*, *bc* always pass through the fixed points *p*, *q*, respectively. Draw the curve traced by the point *b* in moving from *p* to *q*. What is this curve? (1879.)

The dotted lines in the figure show the construction for finding a second point, b^1, on the curve. The lengths *bp* and *bq* vary from point to point of the curve, but the angle *pbq* is constant. The path of *b* is therefore the locus of points from which lines drawn through *p* and *q* diverge at the same angle throughout. But we know from the converse of Euclid III., 21, that the locus is a circle. Hence, after tracing the locus, test it by drawing a circle through the three points *b*, *p*, and *q*, by Ex. 44.

Ex. 102.—Show that the locus of the vertex of a triangle on a given base, and with sides in a given proportion, is a circle.

Test the accuracy of the drawing by the following construction: If AB is the line chosen for the base, and P one position of the vertex, bisect the angle APB, cutting AB at D. Draw PC at right angles to PD, and produce BA to meet it at C; then a circle drawn through PD and C should coincide with the locus which has been drawn.



Ex. 103, Fig. 113.—A boy, starting from *a*, commences to run in the direction *ab*. A man starts at the same moment from *c*. Supposing the man to run also in a straight line, but 1½ times as fast as the boy, what direction must the former take to catch the latter? (1880.)

Find the intersection of the line *ab*, with the locus of points, whose distances from *a* and *c* are in the ratio of 1 to 1½, or find three points on the locus, and draw a circle through them.

Ex. 104, Fig. 114.—Two bars, O_1a, O_2b, are pivoted at O_1 and O_2 respectively. At *i* they pass through a saddle, which can travel along O_1a at ⅖ths the speed at which it can move along O_2b. Trace the locus of *i*. What is this curve? (1888.)

Mark off points along O_1a and O_2b from *i* at distances in the proportion of 2 to 5, and with O_1 and O_2 as centres, draw intersecting arcs through the points. The curve that passes through the intersections is only approximately circular, as the lengths O_1i and Q_2i are not quite in the proportion of 2 to 5 to begin with.

Ex. 105.—Draw two equal ellipses in contact, and suppose one to be fixed and the other to roll upon it. Assuming that a line joining the near (to the point of contact) focus of the one to the further focus of the other remains constant in length throughout, show the paths of the foci of the rolling ellipse.

ELLIPTICAL OR OVAL.

Ex. 106.—A point F is 2in. from a line. Draw half the curve, the distance of every point of which from the given point is to its distance from the line as 2 : 3. (1868.)

Ex. 107.—A line 3in. long moves with its extremities in two lines at right angles. Determine the curve traced out by a point in the line at 1in. from its end. (1867.)

Ex. 108.—A line 4in. long moves with its extremities always in two lines at right angles to each other. Draw the curve traced by a point P in this line produced, and at 1in. distance from either end. (1871.)

Ex. 109.—AB, BC, are two bars linked at B. The bar BC rotates about a fixed centre C; the point A is free to move in a straight line passing through the centre C. The arrangement is therefore that of a crank and a connecting rod. Trace the complete curve described by a point on AB, distant ¾in. from B (AB = 3¼in.; BC = 1½in.). (1879.)

Ex. 110, Fig. 121.—Two rods, AB and BC, are pin-jointed together at B; C is a fixed centre. While B moves in a circle with BC as a crank, end A slides in a ring fixed at R. Draw the path of any point P on the rod AB.

This is the principle of Stanley's "Oograph," which can be used for drawing egg-shaped ovals.

Ex. 111.—A and C are two points 3·25in. apart. B is a third point 1·25in. from A, and 2·75in. from C. Given that A and C are the foci of an ellipse, and that B is a point on the curve, draw that curve. Only half need be shown. (1870.)

Ex. 112, Fig. 119.—Let the figure represent a set of bars, all rigidly connected except *ab* and a^1b^1, which are free to turn about D and C as centres respectively. While a^1b^1 turns from CA to CB through a^1b^1 as a central position, *ab* turns from DA to DB through DC. *ab* and a^1b^1 do not rotate at a uniform rate, but the intersections of a^1b^1 (produced), first with Aa^1 and then with b^1B, also of *ab* with AB, travel along each uniformly. Draw the path of the intersection of the two bars *ab* and a^1b^1.

Divide AB into a number of equal parts, say 10 or 12. Also divide Aa^1 and b^1B, *taken together*, into the same number of equal parts. Then draw lines through the division points, and the centres C and D for successive positions of the lines *ab* and a^1b^1. If *ab* and a^1b^1 be made to exchange places, the counterpart of the curve will be obtained.

Ex. 113.—Reproduce fig. 119, but let the bars be set obliquely (*i.e.*, at some angle other than a right angle), say at an angle of 45 deg. Find the path of the intersection of *ab*, and a^1 b^1 when these move as in the last problem.

Ex. 114.—From any point C, as centre draw two circles, radii CA = 1in., CB = 1½in. Suppose the radial line CAB to pass round like the hand of a clock. Find the locus of a vertical line through B, and a horizontal through A.

The construction involved here is also a very common one for describing an ellipse.

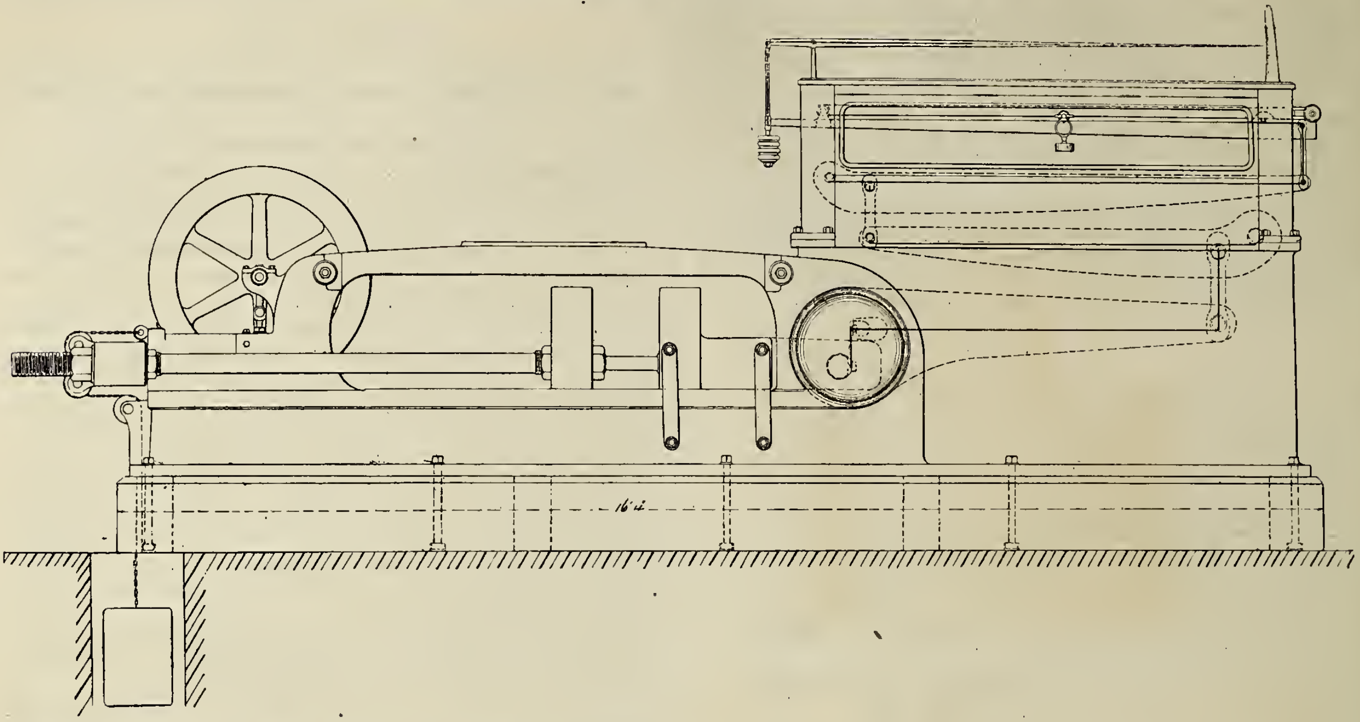
Ex. 115.—Referring to the points AB and C in Ex. 111, draw lines AB, CB, and produce them towards B. On the produced lines cut off equal lengths, say 1in. BD, BE, and with these as two sides of a rhombus, BDFE (*i.e.*, a square moved out of the square), complete the latter. Suppose a pencil at point B to be guided by a string to trace out the ellipse of Ex. 111, draw part of the path of P, a point situated anywhere on BF, the diagonal of the rhombus.

The curve will be found to be parallel to the ellipse described by B. Compare the path of P in this problem with that of P^1 in fig. 103A, which, as was pointed out in Ex. 92, is not a paralled ellipse.

Ex. 116.—A and B, two points 2·25in. apart, are the centres of two circles, radii AC = BD = 2·85in. A line CD moves with its extremities in these two circular paths. Draw the locus of the intersection of radius AC with radius BD.

100-TON QUADRUPLE-LEVER TESTING MACHINE.

CONSTRUCTED BY MESSRS. DANIEL ADAMSON AND CO., DUKINFIELD.



We have pleasure in presenting our readers this week with an illustration of the 100-ton quadruple-lever testing machine, by Mr. Daniel Adamson, a full description of which was given by him in his paper before the recent Edinburgh meeting of the Iron and Steel Institute, and which was published *in extenso* in our issue of Aug. 31st.

The general arrangement and design of the machine were so exhaustively described in Mr. Adamson's paper, that we must refer our readers to it for a detailed description, and content ourselves with stating briefly that the machine, as its name implies, consists of four horizontal multiplying levers, the first or main lever being of the first order, with a multiplying power of ten; the second lever, of the second order, with a similar multiplying power; the third, of the second order, with twelve powers; while the fourth, or registering lever, is of the first order, with a multiplying power of twelve and a half, thus giving a total lever power of 15,000 to 1. In order to test up to the maximum power of 100 tons, four 3lb. weights are used at the end of the fourth lever, each 3lb. weight producing a stress of 45,000lb. on the specimen under test; while, in addition to the end weights, there is a floating weight of 4lb., which is traversed along the lever by a light cord and pulley. The registering lever is subdivided so as to give a record for each increase or decrease of load of 20lb.

The crossheads are designed to take in specimens ranging from 6in. to 7in. in width, while the machine can be readily arranged for testing transversely in lengths of 3ft. downwards, as well as for compression and punching.

In his paper Mr. Adamson stated he had found on investigation that if an attempt were made to limit the distance between the load and the fulcrum unduly, the friction was more than commensurately increased, and in the machine this distance he has found it undesirable to reduce to less than 6 inches. With a view to increase the delicacy of the machine, an additional 10-power recording lever is fixed on the top of the lever box, by means of which it is stated that a movement of 150,000th of an inch in the specimen under test can be readily recorded. As an indication of the delicacy and accuracy of the machine, Mr. Adamson stated that he had been able to detect the movement in a test piece one inch in length, and one quarter of a square inch in area, produced by the mere warmth of the hand, and that the movement recorded was the same when the experiment was repeated time after time, thus proving the reliability of the observations.

IMPROVED FUSIBLE PLUGS FOR STEAM BOILERS.

As many of our readers will be aware, a variety of fusible plugs have been designed from time to time with a view to prevent the overheating of the furnace crowns of steam boilers in the event of shortness of water. None, however, have stood the test of practical working and proved reliable under the various trying conditions that arise in actual practice so well as that which is the property of the National Boiler Insurance Company, and is so well known to steam users as the "double-cone" plug. This plug, in fact, may be fairly said to hold the field, and a boiler is now scarcely considered to be fully equipped unless furnished with this safeguard against low water.

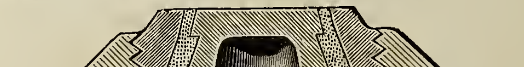


Fig. 1.—Section of Screw-cone Plug.

The accompanying illustrations represent the latest patented improvements in the design of this simple and ingenious device. The present design is the outcome of long experience and observation, and embodies various important improvements which experiments made from time to time have indicated.

A common and serious defect with nearly all the fusible plugs with which we are acquainted is that they permit of *partial fusion*. That is to say, the fusible alloy which may fill or cover one large opening, or a number of small ones, does not melt simultaneously, the result being that when over-heating occurs, the steam, instead of rushing out in sufficient volume to extinguish the fire and call the attention of the attendant to the danger, escapes in a single fine jet, which, while utterly inadequate to check the action of the fire or give an alarm, is yet quite sufficient to prevent the total fusion of the plug. In the "double-cone" plug this imperfect action of the plug is guarded against by what is termed the "protector flange," shown in the accompanying illustrations, and by means of which the escape of the alloy is entirely prevented until the whole of the metal is melted, and the central brass plug is blown out entire, thus forming a large opening, through which the steam and water in the boiler may escape in sufficient volume both to quench the fire and give an alarm to those in charge.

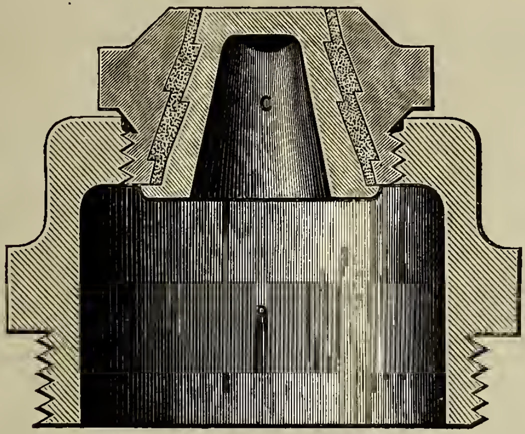


Fig. 2.—Section of Valve-seated Plug.

The flange at the base of the central brass plug not only prevents the premature escape of the fusible metal, but also protects the alloy from the deterioration produced by the furnace gases, which is a point of considerable importance, and enables the alloy to retain its reliability for a much longer period than would otherwise be the case.

The fact that the alloy is apt to become less fusible after the plug has been at work for a considerable time is a point that is too frequently overlooked by boiler attendants, and we have in our own experience met with cases in which the fusible metal has not been renewed for a number of years. We therefore take this opportunity of calling attention to the matter, and of pointing out that it is desirable to renew the fusible plug at convenient short intervals, say at least once every two years. With the "double-cone" plug this is an operation which is easily performed. It involves nothing more than the unscrewing of the central plug or cap, and can be effected in a few minutes. In the "screw-cone" type of plug, a section of which is shown in fig. 1, the plug is screwed into its seating from the fire side. In the "valve-seated" type, shown in fig. 2, the plug is screwed into its seating from the inside of the boiler. This type of plug is designed to meet the requirements of boilers of the vertical and other small types, the furnace crowns of which are frequently inaccessible from the fire side. In both cases the cap or plug is applied without any difficulty, and no cement or packing of any kind is required to secure a tight and reliable joint.

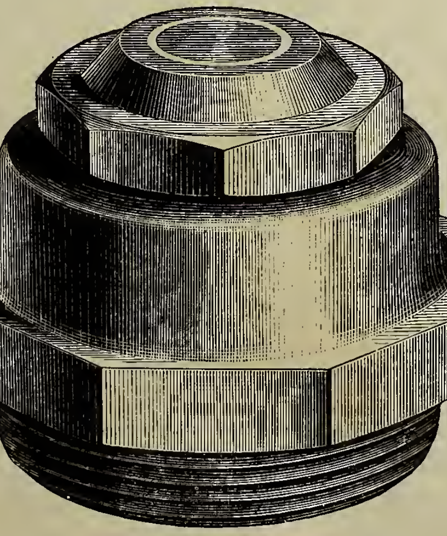


Fig. 3.—External view of Valve seated Plug

The extent and general favour with which the appliance has been adopted may be gathered from the fact that the National Boiler Insurance Company have already supplied nearly 50,000 of these plugs; while their reliability has been proved by the fact that the furnace crowns of hundreds of boilers have been saved from injury by their action.

THE IRON AND STEEL INSTITUTE.

(Continued from page 429.)

Following Mr. Hadfield's paper on "Manganese Steel," was a most interesting one on the Forth Bridge, by Mr. F. E. Cooper, M.Inst.C.E., the resident engineer. It was as follows:—

The Forth Bridge.

To the request to prepare a paper on the Forth Bridge for the present meeting I at once assented, on the understanding that it should take the form of a continuation of that communicated to the institute on the occasion of their visit in 1885 by Mr. B. Baker, who, with Sir John Fowler, is joint engineer of the structure. I therefore propose to confine myself principally to a general description of the methods employed in the erection of the various portions of the main spans.

As it is possible that some of those present have not clearly in their minds the information contained in Mr. Baker's paper of 1885, I will first give a short summary of its contents. The total length of the viaduct will be 8,296 feet, or nearly 1⅝ miles, and there are two spans 1,710 feet, two of 680 feet, fifteen of 168 feet girders, four of 57 feet, and three of 25 feet being masonry arches.

The clear headway for navigation will be not less than 150 feet for 500 feet in the centre of the 1,710 feet spans. The extreme height of the structure is 361 feet above, and the extreme depth of foundations 91 feet below the level of high water.

There will be about 53,000 tons of steel in the superstructure of the viaduct, and about 140,000 cubic yards of masonry and concrete in the foundations and piers.

The main piers, three in number, consist each of a group of four masonry columns, faced with granite, 49ft. in diameter at the top, and 36ft. high, which rest either on the solid rock or on concrete, carried down in most cases by means of caissons of a maximum diameter of 70ft. to the rock or boulder clay, which is of almost equal solidity.

The stresses to be provided for are those arising from the weight of the structure itself, the rolling load, and wind, as well as from change of temperature.

The rolling load has been taken as 1 ton per foot run on each line of rails over the whole structure, or a train on each line consisting of 60 short coal trucks of 15 tons each, headed by two locomotives and tenders weighing in the aggregate 142 tons.

The wind pressure provided for is a pressure of 56lb. per square foot striking the whole or any part of the exposed surface of the bridge at any angle with the horizon, the total amount on the main spans being estimated at nearly 8,000 tons.

The material used throughout is open-hearth or Siemens-Martin steel. That used for parts subject to tension is specified to withstand a tensile stress of 30 to 33 tons to the square inch, with an elongation in 8 inches of not less than 20 per cent. That subject to compression only, a tensile stress of 34 to 37 tons per square inch, with an elongation in 8 inches of not less than 17 per cent. Strips of each class 1½in. wide are to bend cold round a bar, the diameter of which is double the thickness of the strip. The tensile strength of the rivet steel is 26 to 30 tons per square inch.

The superstructure of the main spans is made up of three enormous double cantilevers resting on the three piers before mentioned. Those on the shore sides are 1,505ft., and that on Inch Garvie (an island fortuitously dividing the deep water space into two channels of nearly equal width) is 1,620ft. in length; the effective depth over the piers is 330ft., and at the ends 35ft. The centre portions of the two 1,710ft. spans on each side of Inch Garvie are formed by two lattice girders 350ft. in length and 50ft. deep in the centre, and 37ft. deep at the ends.

The compression members of the cantilevers are, as a rule, formed of tubes either circular in form or circular with flattened sides. The tension members are girders quadrangular in section; the booms at their corners take the strains, and the vertical and horizontal bracing of the sides keep them stiff against the effects of their own weight and wind respectively.

The steel is delivered at the works in plates cut nearly to size, and as angle bars of various sizes and lengths. Plates which have to be bent or shaped are so treated at a red heat in hydraulic presses with moulds of special construction, and all edges are planed. The plates and bars, whether composing circular members, or the booms of the girders with all the required covers, &c., are as a rule assembled in their exact positions, and operated upon by drills of special construction, which, traversing their whole length, bore nearly all the holes required for the riveting.

I will now procced to describe in as concise a manner as possible how the superstructure of the Forth Bridge has up to the present time been erected, and what modifications were found advisable during the progress of the work. It will be convenient to divide the subject into the three following principal groups:—

I. The erection on timber staging, giving support from beneath, by the use of ordinary derrick cranes.

II. The erection by special appliances placed on extensive platforms, or scaffolding, which varied in position according to the progress of the work.

III. The erection by means of special cranes, which, resting on the members themselves, enabled the latter to be extended, and in turn become the support of the former.

This last system allowed the use of temporary appliances to be reduced to a minimum.

Group 1.—The first plates of the superstructure comprised in this division that were dealt with were the lower bed-plates, which rest on the masonry piers, and ultimately transmit to them the whole weight of the superstructure, rolling load, &c. The plates forming these were put together upon iron supports sufficiently high to enable the girders carrying the holders-up of the hydraulic riveters to be manipulated beneath. Under ordinary circumstances the upper bed-plates would be the next parts put together, but the skewbacks, as the massive junctions at this point are termed, and of which they formed the foundations, were not as a rule sufficiently advanced to enable this to be done. Therefore, to save time, the tubular bottom members between the skewbacks were first erected and riveted in their ultimate position, and in some cases, for a similar reason, the transverse and diagonal bracing girders were completed at an early stage. As soon as it was possible to obtain them, the upper bed-plates and skewbacks were erected, the former, as in the case of the lower bed-plates, in an elevated position, for convenience in riveting, being afterwards lowered. Next those portions of the vertical columns, diagonal struts and bottom members over the piers, and first struts and bottom members of the first bay of the cantilevers, extending to about 40 feet above or beyond the masonry, and within reach of the ordinary derrick cranes, were placed in position. The timber used temporarily in the staging for the support of these amounted to about 10,000 cubic feet in the case of Queensferry and Fife piers, and rather more at Garvie, and the amount of steel thus erected was about 2,000 tons in each of the two former, and 2,600 tons in the case of Garvie.

Group 2.—The point was now reached at which the appliances under Group 2 were brought into play, and it was only after careful and protracted consideration that the system made use of was adopted. The principal conditions laid down with reference to the central portions of the double cantilevers were: 1. That in order that the men should be able to work at any height in as great security and comfort as if on the level of the ground, platforms or scaffolding of considerable area should be provided. 2. That the raising into position of the several parts of the structure should be as little as possible interrupted by wind, the ordinary derrick cranes not being then considered applicable. 3. That the weight of the platforms and apparatus should not much exceed 400 tons. 4. That the connections forming the supports should not bring excessive strains upon any part of the permanent structure. 5. That no rams of the lifting apparatus should have to exert a lifting force of much more than 100 tons. 6. That the platforms should form ultimately stages for building the top members over the piers. 7. That, for the sake of economy, material forming part of the permanent structure should be made use of temporarily as much as possible.

The platforms provided were two in number, one on each side of the axis of the bridge. They were 20 feet wide, and 200 feet long at Fife and Queensferry, and 350 feet long at Garvie, composed of timber planking and joists, which rested on two longitudinal girders, one on each side of the vertical columns, formed of part of the booms and bracing of the first permanent ties of the cantilever. These were carried by cross girders, constructed of plates forming part of the second and third permanent struts passed through the northern and southern pairs of vertical columns respectively, plates being temporarily omitted for the purpose. A double set of short cross girders inside each vertical column formed the supports for the hydraulic jacks, which raised, when necessary, the cross girders first referred to, and with them the platforms. The cross girders inside the columns were supported by means of pins passing through their ends, and through the webs of the I-beams forming part of the vertical columns. The main lifting rams were 13½ inches in diameter, and were capable of lifting 240 tons with the water supplied to them by special pumps, at a pressure of about 30 cwt. per square inch. The total weight actually lifted by the four rams did not, as a rule, much exceed 450 tons, exclusive of friction.

The plates and beams forming the vertical and diagonal columns were raised by ordinary hoists to the level of the platforms. These were then taken by small trollies to a goliath, running along temporary rails on the surface of each platform, which lifted them into and held them in place while they were bolted to those previously built. Riveting machines, of special and ingenious design, suspended below the platform, dealt with those portions of each tube allotted to them. As soon as a 16-feet length of the vertical columns was riveted below, and a similar length added above, the hydraulic jacks were set in action, and the platforms were raised by successive steps of one foot, a height of 16 feet, when the above described operations of building and riveting were resumed. In this way those on the centre portion of the Queensferry cantilever were raised the extreme distance of 281 feet in about twenty-four weeks. The platform girders were then trussed by links formerly used in Old Hammersmith Bridge, and upon them the massive girders forming the top members of the cantilevers, between the vertical columns, were put together and riveted. The timber platform was then laid upon the latter, and the lifting platforms and their girders and other appartus were taken apart and lowered piecemeal.

The lower members of the cantilevers, formed in tubes 12 feet in diameter, were extended outwards from the piers for about 40 feet by means of ordinary cranes. Beyond that point they were erected by means of an ingeniously devised crane fitted with hydraulic lifting, turning, and traversing gear. This crane was seated on a carriage, movable along the top of a framework 20 feet square and 48 feet long, first built in sections upon and surrounding the tube itself. As each section of the latter was completed in front (the men employed in bolting up, &c., standing on the timber flooring supported on the bottom of the framework), the crane was used to transfer the sections of the framework, previously unbolted, from the back to the front, and in this way the tube by successive operations was built out for a distance of about 160 feet from the piers. As in the case of lifting platforms for the central portion, the objects kept in view in the design of this apparatus were large working platforms for the men, and for the putting in place of material cranes actuated by hydraulic power with a short lift.

For the erection of the lower portion of the first strut, and of the first vertical tie and support to the internal viaduct, lifting platforms, similar to but smaller than those first described, raised by jacks placed in the vertical tie and on the vertical columns, were used. These were originallay intended to have been carried up to the level of the underside of the top members, and upon them, when strengthened, those members were to have been built; but the experience gained up to this time as to the ability of the men to work unaffected in situations more exposed than was at first deemed advisable, as well as to the ease with which large and heavy pieces of material could be raised great heights by ordinary cranes and tackle with little interruption from anything but a strong wind, rendered it possible for a great modification to be made in the mode and apparatus made use of, and these platforms were carried no higher than the level of the intersection of the first ties and struts. The appliances used on the erection up to this point, though amply fulfilling all the conditions of the problem, were necessarily slow in action, and costly to make, put together, and take down; and it must be borne in mind that when the vertical columns, with their bracing and top and bottom members connecting them, were completed, an immensely powerful support was available from which the other members of the cantilever and the internal viaduct could be held up by temporary stays as securely as if supported by staging on the solid ground below. The weight of the portions of Fife and Queensferry cantilevers erected under Group 2 was about 3,000 tons each; at Garvie it was somewhat more.

Group 3.—With the exception of the first bay of the lower members, the first 120 feet of the internal viaduct, and the lower portion of the first struts, the whole of the principal members of the cantilever are included in this group.

Two types of special cranes are employed, one made use of to build the top members and upper halves of the struts and ties. The other is traversed along the internal viaduct, and deals with the remainder of the work. The top member crane is provided with a horizontal jib, 35ft. in length, which can be slewed through an arc of 230 deg., and along which the suspending pulleys can run. The lifting of the material is effected by a steam winch, the main drum of which accommodates about 400ft. of wire rope 1¾in. in circumference. This crane is supported on a carriage formed of two steel cross girders strongly braced, and which rest on the upper surface of the angles connecting the vertical webs to the flanges of the booms of the top members, and along which, when desired, it is traversed by means of powerful screws. In some cases, at the back of the carriage a hydraulic crane is attached, along the horizontal jib of which run the supports for a hydraulic riveter, used for completing that part of the work within its reach. An ordinary derrick crane is sometimes substituted for this part of the apparatus.

Beneath the top member, and strongly attached to the carriage of the crane, is suspended, on four longitudinal girders, a roomy platform of timber, 76ft. long and 45ft. wide. The building operations are thus carried on. Each length of the vertical webs of the top members is first raised by the ordinary hoist to the level of the internal viaduct. It is then carried on a trolly to a point beneath the jib of the top member crane, which raises it to its exact position, and holds it there, while the men standing on the platform bolt it to that already complete.

The lower booms are first thus secured, then the vertical and horizontal bracing bars are fixed, and lastly the top booms. When the length is complete, the carriage is slid down a convenient distance, and the building operations are again resumed, and are continued until the member reaches the centre of the bay. When, in the case of bay 1, the overhang was 125ft., and the strain on the vertical bracing (temporarily doubled) had nearly reached the working strain of 6½ tons per square inch, with the end of the members deflected about 8in., a temporary continuation of the vertical tie in the centre of the bay was built up to the underside of the top members, and jacks being interposed, the latter were raised the amount they had deflected, and secured by wedges. Similar extensions of the vertical ties will be required in the case of the other bays in order to support temporarily and adjust the top members above them. The crane then continued the building until the top members reached the junction at the upper ends of the first struts, where any deflection in them was again removed, and the permanent connections at this point were completed.

At convenient intervals, the building of the top member was suspended, and the crane employed first in building down the ties, which operation was similar to that already described for the top members, except that the men occupied stood on small timber stages suspended from and enveloping the member, and which were lowered as required by ordinary tackle. Afterwards, the upper halves of the struts were built in the same way, except that the extension was in the reverse direction. In order to prevent excessive strain on the unsupported lengths of both ties and struts, temporary struts from the vertical columns were put in where required, light girders and wire ropes being also largely made use of.

The internal viaduct crane consists of two masts and jibs of the derrick type, the former in line transversely with the axis of the bridge, and 16ft. apart, braced strongly together, and secured to a movable timber frame traversed along the outer rail troughs of the viaduct. Each jib is raised and lowered by means of a wire rope passing round a drum on the mast, but the wire rope lifting the material is passed through a sheave at the extremity of the jib; thence it is led over a sheave down the centre of the mast, and by means of guide pulleys to some convenient point on the finished structure, whence to a steam winch. The object for separating the power from the crane is to lessen the weight concentrated at that point, the viaduct there being extended much in advance, and as a rule acting as a cantilever, its outer end being temporarily supported by wire ropes to some part of the finished structure. When the viaduct girders are being extended by these cranes, little staging is required, the men being able to do the bolting up standing in the troughs forming the top and bottom booms.

To provide the necessary standing room for the men when at work on the lower members, light platforms of timber are hung from the tubes by trusses of convenient form. For the building of the lower portions of the struts and ties the same stages are used as described in the case of the upper portions of these members. Steam winches, with blocks and tackle attached to convenient points, are used to lift into and hold in position the parts, not usually exceeding two tons in weight each, of the wind and other bracing of the various members, the men doing the bolting up either hanging on to the parts themselves or standing on planks placed where necessary.

Wire ropes are now almost entirely used for the cranes, running gear, and temporary support, being found most trustworthy, and, when treated properly, should never give way. An extensive series of experiments has been made with regard to the proper use of this material, and, as a consequence, the following conditions are adhered to as much as possible :—The material should be crucible cast steel. The number of wires should be numerous. The diameter of the pulley or drums should not be less than six times the circumference of the rope. A marked increase in the life of the rope is observed when even this proportion is exceeded, the number of bends under load before beginning to fail with six circumferences being 5,000, and with eight circumferences 10,000, while destruction occurred at 15,000 and 36,000 bends respectively.

(To be continued.)

RECONSTRUCTION OF THE TOWERS OF THE NIAGARA SUSPENSION BRIDGE.*

The towers of the Niagara Suspension Bridge were originally built of dressed limestone masonry, set in cement mortar, and were founded upon the rock on each side of the channel. The base of each tower consisted of a pair of massive abutments, flanking the roadway which leads on to the lower platform of the bridge, and united by an arch at the level of the railway which is carried upon the upper platform of the bridge; while above the railway each tower was carried up as a pair of pyramidal piers, each of which was 15ft. square at the base, and 8ft. square at the top. At the summit of each tower the main cables of the bridge were carried upon cast-iron saddles, resting upon cast-iron rollers (5in. in diameter) and planed bed-plates. From the top of the towers the cables are carried down as land-ties to the anchorages, these portions of the cable being as nearly straight as their weight will allow them to lie, and having a deflection which averages in fact 15in. The calculated movement at the top of the towers, due to the further straightening of the land-ties under the pull of the live load, is about ⅝in., while the greatest movement due to the change of temperature would be about 2in., or 1in. in each direction; so that, from its normal position, the saddle should move altogether a distance of 1⅝in. towards the river, and a distance of 1in. towards the land.

Soon after the completion of the bridge it became apparent that the stone of which the towers had been built, and which had been quarried near the site of the bridge, was not adapted to withstand exposure to the weather; and painting was resorted to as a preservative, and was afterwards repeated at intervals as long as the towers were retained, while new face-stones were also inserted from time to time to replace defective work. But in 1880 the appearance of the masonry gave rise to the belief that another disintegrating agency was at work. The cracks, which had begun to develop themselves in various directions some years previously, were now especially conspicuous in such position and direction as to indicate the action of a transverse bending stress upon the towers, due to the elongation and contraction of the land-ties under changes of load and changes of temperature. The maximum movement of the saddles under these changes should be as above calculated; but it was now found that in the year 1880 the greatest movement of the saddles with respect to the bed-plates was only ⅛in.; while it was impossible to inspect the actual condition of the rollers, or to remedy any defect in their working, owing to the fact that they were enclosed between heavy ribs, 7in. deep and 2½in. thick, cast in one with the lower bed-plate, and forming the only guides to prevent the saddles from working off laterally.

Under these circumstances, the author was of opinion that any plan for buttressing the towers, or otherwise attempting to prevent their bending, would only prove abortive; but it was decided to cut away all the defective face-work, replacing it with new stones thoroughly bonded into the heart of the work, and it was hoped that the new face-work would have sufficient elasticity to allow of the swaying of the tower without crushing the stones.

This re-facing of the towers was completed in 1883; and during its execution it was discovered that the cracks in the masonry had not been confined to the facing, but had extended into the body of the towers, and that in some cases these internal cracks were of serious and somewhat alarming extent.

A close watch was kept, in order to detect any further changes that might occur, and in 1885 the work was subjected to another detailed inspection, whose results showed that the disintegration of the towers was still progressing—the joints having been opened in some places, while in others the new stones had been cracked through; and at one point a portion of the masonry appeared ready to fall out.

It was then finally determined to reconstruct the piers altogether in wrought iron; and this has been effected without interfering with the other portions of the suspension bridge. In each tower the two piers consist each of four wrought-iron columns, united by longitudinal and transverse bracing, while the two piers of each tower are also united by transverse bracing. The columns having been erected and temporarily clamped to the masonry towers, the weight of the bridge was transferred to them by slinging up the old saddles together with the main cables lying over them, and raising them off the old rollers by means of a set of hydraulic jacks.

When access to the old rollers was obtained, they were found to be embedded in cement and iron rust, the spaces between them, and between their ends and the ribs of the bed-plate, being filled with this cement, which had become so firm that a chisel-bar was required to extricate the rollers. Thus each roller was lying in a trough, and whatever water found its way into it could only escape by evaporation. The bending strain produced in the towers by this fixity of the old rollers was evidenced on the occasion of lifting one of the saddles during very cold weather, when the top of the tower was observed to spring forwards towards the river by ⅝in. as soon as it was released.

The old rollers appear to have been placed side by side without a roller frame, with a play of ¼in. between their ends and the fixed ribs of the bed-plates; but the new rollers were formed with trunnions running in holes in the side bars of a roller frame whose depth is greater than the diameter of the new rollers, and overlaps the steel-bearing plates above and below the rollers, the edges of the frame being planed to come into neat contact with the edges of the steel plates and the shoulders of the rollers. By this arrangement the rollers are protected from water, and, as far as possible, from dust.

During the period when the weight of the bridge was being transferred from the old to the new towers no trains were allowed upon the bridge. The transfer, when everything had been prepared for it, occupied eight hours and a half, the transfer including the removal of the top three courses of masonry.

The maximum load resting upon each pier is estimated at 900 tons; and in the original structure the area covered by the rollers was 3ft. 4in. by 4ft. 7in., or 17·18 square feet; while the bed-plate could not effectually increase the area of distribution to more than 25 square feet; so that the load would cause a pressure of 36 tons per square foot upon the masonry.

T. C. F.

Foreign Abstracts, Proc. Inst. C. E.

COMPOUND LOCOMOTIVES AND THE RACE TO EDINBURGH.

(CONTRIBUTED.)

SINCE I sent you an account of the working of compound locomotives on the Worsdell system in comparison with the ordinary locomotive (which appeared in your issue of April 20th), there has been a race from London to Edinburgh between the East Coast route (Great Northern and the North-Eastern Railway Companies) and the West Coast route (the London and North-Western and Caledonian Railway Companies). There is no doubt but that on both they have selected the most suitable locomotives to run these fast trains, to gain the supremacy for running the distance in the shortest time. My object in writing this paper is to further prove that the compounding of locomotives on Worsdell's system is superior, both for economy, power, and speed, than the ordinary locomotive. To commence with, I must state that with a few exceptions all the trains in the race on the East Coast route were run from York to Edinburgh by Worsdell's compounds, one taking the train from York to Newcastle, and another from Newcastle to Edinburgh (with never less than eight coaches), and, with one exception, arriving before the specified time.

On August 31st, compound No. 117 started from Newcastle at 3-19 p.m., and arrived in Edinburgh at 5-26 p.m., having run the distance of 125 miles in 127min., and the driver states that he had to pull up three times for signals to about four miles an hour, which caused a loss of about 4½min., thus bringing the actual speed to 125 miles in 123½min., which, considering the fact that the train consisted of eight coaches well laden, beats any previous locomotive record, at any rate to my knowledge; and taking into consideration the average saving of fuel, as shown in my previous paper, of 4·4lb. per mile over the non-compounds doing the same work, I think I have proved without doubt that the compounding of locomotives on Worsdell's system is superior to any other locomotive running at the present day.

These compounds were built at the North-Eastern Railway shops, Gateshead, and are fitted with the latest and most economical improvements for lubricating.

CORRESPONDENCE.

We do not hold ourselves responsible for the opinions of our Correspondents.

THE FIRST CENTURY OF THE MARINE ENGINE.

To the Editor of "The Practical Engineer."

SIR,—With reference to your correspondent's letter, in your issue of the 31st ult., on your concise and interesting paper on the above subject, are not his remarks slightly superfluous and rather inaccurate? In the first place, he states that Watt took out a patent for the crank, but it is well known that Watt often repented not having done so in 1771, when he proposed it, as he was afterwards prevented adopting it for some time by the patent of a certain Matthew Wasborough; hence the reason for his patenting, in 1781, several devices for obtaining a rotary motion from a parallel one. Perhaps the best known of these was the "sun and planet wheels," fitted to many of his engines, and afterwards altered on the expiration of Wasborough's patent. Again, with reference to a boat in Scotland (the Charlotte Dundas, I presume), Mr. Holt states that she was laid aside because of injury to the banks of the Clyde. As it does not seem to have been suggested that the boat should run on the Clyde, even if the banks were considered damagable, I suppose Mr. Holt meant the canal, as that was suggested only as an excuse, and could not really have been the case, or Lord Dundas, who was largely interested in the canal, would not have ordered eight similar vessels from Symington as "tow-boats" for the canal. These boats were never built, possibly owing to the death of Lord Dundas, who supplied the capital, but more probably for the same reason that the Charlotte Dundas was abandoned, viz., Bolton and Watt threatening them with legal proceedings for infringement of patent rights, and only overlooking the first vessel as an experiment not likely to be attended with any particular results.

Besides this, the idea of damage to canal banks from the wash of the paddles could easily have been overcome by having the vessel constructed on Miller's first plan, viz., a double hull with wheel between.

This plan was afterwards tried on the Clyde, in a steamer named the Alliance, built by Messrs. Todd and Macgregor, in 1857; but proving too slow to compete with the ordinary river boats, she took the station on the Caledonian Canal, in connection with Messrs. Hutchinson's steamers, for which purpose she seems to have been well suited. She afterwards did good service as a blockade runner, but was subsequently captured, and sold to go to New Zealand, where she was wrecked.

In conclusion, does not Mr. Holt rather over-estimate American rimentalists and copyists? Amongst the former I understood that Fitch and Rumsey took a leading place. In 1785 he invented and worked out a hydraulic propeller, and afterwards a kind of chain paddle, which worked on two shafts. This same plan was tried about 1850 in a Clyde river steamer, the Merlin, and was then known as "Kibble's patent chain floats; but this proved a failure. I think it was also Fitch who experimented with a small screw steamer in a pond in New York, about 1769. As to Fulton, it is well known that he got the particulars of Miller's experiments, proofs of which are to be seen in the dimensions of the Clermont's engine, which, of course, it will be remembered was built by Boulton and Watt.

Hoping you will find space for the above remarks in your valuable and interesting journal, I am, yours, &c., A. F.

Barrow-in-Furness, Sept. 5, 1888.

PUMPING WATER.

To the Editor of "The Practical Engineer."

SIR,—The letter on pumping water, in your issue of August 31st (p. 419), leads me to say a few words more as to what is possible to be done with the pump under the conditions stated. "Tangye Pump" does not tell us the length of stroke, nor the average velocity of the ram, but he tells us what is quite pertinent to the purpose—that the 4in. pipes supply sufficient water for the ram to work perfectly solid at thirty strokes per minute and, when the pump goes quicker the ram barrel is only partially filled.

The flow of the water through the 150 yards of 4in. pipes, from the river to the pump, must of course be intermittent, and, at thirty strokes per minute, must make a flow during each alternate second, and a pause or rest during the intermediate second. With a continuous steady flow in the above 150 yards of 4in. pipes, having a lift of 12ft., as stated, a maximum velocity of about 6ft. per second may be continuously maintained; while, with an intermittent flow, the average velocity could only be half of the above, and, indeed, it must be much less, inasmuch as the inertness of the great mass of water in the pipes, after each pause, further reduces its average velocity very nearly one-half in passing into the pump barrel, and the effect of that inertness increases as the square of the speed of the pump. If, then, a continuous flow in the pipes could be maintained in such quantity as we know from the above statement of "Tangye Pump" that the pipes are capable of passing, the quantity of water passed through them per minute would be three or four times that delivered by the pump while going at thirty strokes per minute, and would in fact be more than double the quantity spoken of as being required.

In the arrangement described in your issue for August 24th (p. 406), we have the means for producing such a continuous flow into the partial vacuum vessel in the simplest manner possible, from which the pump, although it be but single-acting, may draw say three or four times the quantity of water it could obtain when going at thirty strokes per minute, as it has hitherto been worked, and this may be done without the necessity of disturbing the present supply pipes, or adding an additional pump.—Yours, &c., W. A.

Manchester, September 3rd, 1888.

WROUGHT-IRON BELTING.

To the Editor of "The Practical Engineer."

SIR,—Anent the adoption of wrought-iron belting, I would point out that in the earlier experiments of M. Hirn in the telodynamic transmission of power, he first used an endless steel band running upon pulleys lined with wood. He, however, abandoned the steel band in favour of wire rope. The ends of the band were brazed together, a much better arrangement than that of riveting, recently adopted.—Yours, &c., MARK H. CRUMMIE.

September 8th, 1888.

EVAPORATIVE TESTS.

To the Editor of "The Practical Engineer."

SIR,—I offer you and your correspondent, "W. A.," my sincere thanks for the very full reply to my query, which explains the troublesome quantity "0·3" very fully. Rankine assumes all his readers have as good and clear a knowledge as himself, and those who have not had the opportunity of examining the alphabet of the science are practically lost; but with such a detailed explanation as that kindly given by "W. A.," in your issue for August 31, I am sure none need despair of fully understanding the question.—Yours truly, SCRIBER.

September 11th, 1888.

LARGE GOLD NUGGETS.—The *Melbourne Argus* states that a nugget, weighing 386 ounces, and estimated to yield 375 ounces of pure gold, was, on July 23, discovered in the workings of the Burnt Creek Company, Dunolly. This is the largest nugget found since July, 1887, when one weighing 617 ounces was unearthed in the Midas claim. Two months previously a nugget of 169 ounces in weight was discovered in the ground of the same company. These are the three largest nuggets found in the colony since August, 1880, when one weighing 330 ounces was found in Shicer's Gully, Wedderburn. A report was also received by the Secretary for Mines (Mr. C. W. Langtree) that a party of miners at Wedderburn, at 6in. below the surface, had dug up a nugget 44 ounces in weight.

QUERIES AND REPLIES.

Pumping Water.—In a letter by John Ashton, in your issue for August 31st, page 419, it is stated that "in lifting water by suction 12ft. high, it is equivalent to giving a head of 22ft." Will you please say if this is correct, and if it is explain why?—M. P., New Wortley, Leeds.

Answer.—The statement made by our correspondent was quite correct, but "M. P." will probably understand the matter better if it is put in another way. In a perfect vacuum at sea level water would rise to a height of about 34ft., slightly more or less according to the height of the barometer. In other words, the column of water would give rise to the same pressure at its base as the atmosphere does, viz., from 14lb. to 15lb. Now, the velocity with which water or any other liquid flows depends on the pressure behind it, or, to put it more plainly, on the difference between the pressure in the vessel from which it flows and that into which it is flowing. This pressure is termed the "head," and is generally expressed in feet of water. If we conceive of a pipe in which there is a perfect vacuum connected, say to the sea, it is evident that this water would at first flow in with a velocity due to a head of 34ft. as nearly as may be, and that the velocity of flow would get gradually less and less as the water ascended in the pipe until a height of 34ft. was attained, when the velocity would be nil. With regard to the velocity due to a given "head," it can be readily proved that, neglecting friction, this is exactly equal to that which would be acquired by a body falling freely through the same distance under the action of gravity; so that

If h = head of water in feet,
g = gravity = 32·2,
v = velocity of flow in feet per second.
Thus $v = \sqrt{2 \times g \times h} = \sqrt{64{\cdot}4h} = 8\sqrt{h}$.

In other words, the velocity of flow equals eight times the square root of the head in feet very nearly.—Ed.

Perrett's Patent Furnace.—Can any reader furnish me with the address of Perrett's patent furnace for burning small coal or "breeze?"—Stoker.

Answer.—Messrs. Bryan, Donkin, and Co., Southwark Park Road, Bermondsey, London, S.E., and 10, Mawson's Chambers, 28, Deansgate, Manchester, write us to say they will be pleased to give "Stoker" full information in reference to their Perrett's patent dust fuel furnace.

Lift for Pump Clacks.—Will you oblige by giving the required lift for pump clacks or valves, and how to calculate the same in plain figures? Ex. 1.—For a 5in. ram pump, 2ft. 6in. stroke, running 30 revs. per min. Ex. 2.—For a 9½in. ram pump, 1ft. 9in. stroke, running 26 revs. per min.—Engine Attendant.

Answer.—The lift of a valve should be sufficient to give the same area through the valve as through the pipes, and this is to be obtained by making the lift equal one-fourth of the diameter of the valve. I generally make the lift, however, a little more than this, so as to be sure there is no throttling.—H.

Average Temperature.—Could you or any of your readers give me an average temperature of the weather from June 25th, 1886, to June 25th, 1887, and from June 25th, 1887, to the same date in 1888? You will see what I mean when I inform you that we have burnt over 200 tons of slack more this year than last, and we have no extra heating to do—less, if anything, than the year before.—Engineer.

Answer.—The average temperature of the British Isles from the 1st July to 30th June inclusive, 1886-7 and 1887-8, as found from the monthly weather reports, is 48·8 deg. F. and 47·7 deg. F. respectively, that is, a difference of 1·1 deg. F; as, however, "Engineer" does not state in what locality he resides, and the average temperature not being constant, below are given the averages at the different positions indicated, the Isle of Man being taken as central. From this "Engineer" may probably be able to obtain the information he requires.

1st July to 30th June.	North.	South.	West.	East.	Central.	Mean for the British Isles.
1886-7	46·2	50·9	50·3	47·9	49	48·8
1887-8	44·8	50	49·4	46·5	48·2	47·7

Orion.

Starting Gear.—A sketch and description of "Brown's steam and hydraulic starting gear" would be appreciated by S. B.

Answer.—Replying to "S. B.'s" query respecting "Brown's steam and hydraulic starting gear," I beg to refer him to the paper read by A. Betts Brown, Esq., at the 25th Session of the Institution of Naval Architects, 3rd April, 1884, "On the application of hydraulic machinery to the loading, discharging, steering, and working of steamships." In this paper he will find details, with a full description of the starting gear, along with other hydraulic machinery made by Messrs. Brown. If he is unable to obtain the paper, and will acquaint me through these pages, I will try and oblige him with a sketch.—Orion.

Pressure of Spiral Springs.—Could any of your readers give me a rule for calculating pressure spiral springs will stand when compressed to a given length, the full length, diameter, and section of wire being known? Rule wanted for round and square section steel.—G. B.

Answer.—The following is the formulæ given by Molesworth for the deflection of helical springs: Let F = the deflection in inches, W = working load in tons, n = number of revolutions of spring, T = modulus of torsion (about ⅓ E), E = modulus of elasticity of steel in tons, b = side of square section in inches, D = diameter of spring steel (if round) in inches, R = mean radius of spring in inches.

Note.—E varies, according to quality of steel, from 13,000 to 20,000 tons, say 16,000 tons.

For square section $F = \dfrac{R^3 W 12 \pi n}{T b^4}$ (1). For round section $F = \dfrac{64 n WR^3}{TD^4}$ (2).

Now, transposing these formulæ to suit the case which "G. B." gives, we have for square section, $W = \dfrac{FTb^4}{R^3 12 \pi n}$ (3). For round section, $W = \dfrac{FTD^4}{64 n R^3}$ (4).

In designing some escape valves recently, I had occasion to use formula (1), taking $T = \dfrac{16{,}000}{3} = 5{,}333{\cdot}3$ On testing the valves to the given pressure for which they were designed it was found that the deflection was about 25 per cent in excess of that given by the formula, so that, for the steel used, the modulus E required to be $\dfrac{16{,}000 \times 100}{12{,}500} = 12{,}800$ tons, or say 13,000 tons, which is the lowest figure given in Molesworth.

D. K. Clark's formulæ are much simpler than the above, as follows: Let W = load in pounds, D = size of steel in sixteenths of an inch, E = deflection in each coil, n = number of coils, d = mean diameter of spring in inches, F = total deflection = nE, c = a constant = 30 for square section, and 22 for round section steel.

Then $W = \dfrac{D^4 CE}{d^3}$ (5); if the total deflection is taken, then $W = \dfrac{D^4 CF}{d^3 n}$ (6).

On comparing the deflection by formula (5), the difference was only 2·5 per cent less than the actual deflection found on testing, so that I can recommend the latter to "G. B."

For *conical* springs, Molesworth says: "With constant cross sections of steel, the deflection equals from one-quarter to one-third that of a cylindrical spring whose radius equals that of the base of the cone."—Orion.

Answer.—In reply to "G. B." as to formula for calculating the pressure or tension of steel spiral springs, I beg to offer the following:—

If D = diameter of spiral coil from centre to centre of wire in inches;
d = diameter of wire in inches;
n = number of coils;
E = extension or compression of spring in inches;
W = load in lbs. carried by the spring;

(1) Then $W = \dfrac{1312500\, E\, d^4}{n\, D^3}$.

This formula, slightly modified, I think is from Rankine.

(2) Or thus, $W = \dfrac{22\, ED^4}{n\, D^3}$,

where d = diameter of wire in sixteenths of an inch.

This formula is by the Association of Engineers.

(3) Or again, $W = \dfrac{125E\,(10d)^4}{nD^3}$

The greatest safe working load to be applied on the springs in any case must not exceed $\dfrac{0{\cdot}2\, f\, d^3}{D}$ where f is the greatest safe shearing stress.

The several formulæ above are for round wire, and the value of W for square wire, whose side = d, may be obtained by multiplying its value for round as above, $\frac{15}{11}$ in each of the above (1) (2) (3) formulæ.

The writer having long ago devised the last formula (No. 3), has tested it in the course of business by hundreds of experiments.

For safety valve springs:

When W = load or pressure on the spring in lbs.
D = diameter of coil in inches from centre to centre of wire.
d = diameter of wire in inches if round, or side of square if square.
C = 8,000 for round, and 11,000 for square wire.

$$d = \sqrt[3]{\frac{W \times D}{C}} \text{ and } W = \frac{c\, d^3}{D}$$

Opening between coils when compressed = thickness of spring × 0·4.—W. A.

Tempering Steel Tools.—Can any reader tell me what is the best method for tempering steel springs and cutting tools?—Electron.

Book on Railway Switches and Crossings.—Can any reader of your practical and valuable paper inform me of the most modern edition on railway switches and crossings, with name of author, and cost?—W. L.

Artificer in the Navy.—Can any of your numerous readers afford me any information as to the steps required to become an artificer in the navy? Is it requisite to pass an examination? and is it necessary to enlist for any length of time? What is the rate of pay? If an examination has to be passed, what books is it desirable to study?—W. H. A.

Helical Wheels.—Can any of my fellow-readers inform me of the best mode of setting out the teeth of a pair of bevel helical wheels, the larger wheel to be 34·8in. diameter, with 6in. face and 73 teeth, 1½in. pitch, and the smaller one or pinion 18·14in. diameter, with 6in. face and 38 teeth 1½in. pitch? Also a plain spur wheel 77·98in. diameter, with 140 teeth, 1¾in. pitch, to work in a pinion 40·1in. diameter, with 72 teeth. Any information with regard to making the patterns would oblige.—J. W. J.

Navy Electrician.—Could you or any of your numerous readers give me any information as to the requirements of electricians in the Navy, and how one who has a good knowledge, both practical and theoretical, of electric lighting may become one?—T. H.

Cement for Brass.—Will you or some of your numerous readers kindly give me a recipe for or the name of the best manufactured cement for brass? I want to attach brass rings to the outside of a brass cylinder by means of cement.—Marine.

Timber Tests.—I should be glad if you could give a very simple, reliable, and easily applied available test as to whether timber, especially oak, ash, deals, and elm, are thoroughly seasoned and ready for use—that is, in planking and cut up in cases, where it cannot be ascertained how long it has been cut down and sawn, &c.—Inquirer.

Coal-mining.—Thanks to "H." for answer to my question; will he be so kind as to give me the reason why he would make the return the largest in all cases if a drawing road is not required?—A Deputy.

Flat Cast-iron Surfaces (Ribbed).—Any reliable data for calculating the bursting pressure of a flat cast-iron ribbed surface, such as a steam chest cover, or casing side, will be thankfully received by Orion.

TO CORRESPONDENTS.

Y. S. X.—If the pump is single-acting, the water is only discharged each alternate stroke, and therefore the statement we made is self-evidently correct.

D. Edwards.—As already explained, we have answered your question as fully as it is possible to do without having an indicator diagram before us. From the data you give it is evident the engine cannot be driving more than 5 I.H.P., and as the pressure in the cylinder will no doubt be rather less than that in the boiler, the power will be less than this.

T. R. V.—See answer to query *re* Science and Art Examinations in our issue of August 24th, page 407. We may, however, supplement the list of books there mentioned with the one on Applied Mechanics, by Messrs. Cryer and Jordan, recently published. This, in fact, we should think would probably be better adapted to meet your requirements. The price is 3s., and it may be obtained through this office. We note that you do not give your name and address, and therefore may say for your benefit, as well as for that of some other correspondents, that we cannot undertake to reply to any communication unless these be furnished.

MISCELLANEA.

Fast Armed Cruiser.—The fastest armed cruiser in the world is said to be the German vessel Greif, which has a displacement of 2,000 tons, and is fitted with engines of 5,400 indicated horse-power. On the voyage from Kiel to Wilhelmshafen a speed of 23 knots was obtained.

The Cleveland Iron Trade.—The Cleveland ironmasters' return of stocks for August shows the large decrease of over 22,000 tons, bringing down the total stock of Cleveland pig iron to 482,676 tons, 155,000 tons reduction since the year commenced. The production was 222,000 tons, of which 99,000 tons were hematite, &c., and the remainder Cleveland iron. Three more furnaces are making Cleveland iron than in July—namely, 59—and 38 are on other descriptions of iron. Heavy shipments and larger home consumption have occasioned the reduction.

The Proposed Midland Ship Canal.—An influential meeting was recently held in Birmingham to consider a proposal for the construction of a canal for coasting vessels between Birmingham and the Weaver, in Cheshire. A sub-committee then appointed to examine the project have now reported favourably as to its practicability, and the prospect of its construction, acquisition of land, and water rates at a reasonable cost. A guarantee fund is to be opened to defray the expenses of a detailed survey and of the preliminary steps for an application to Parliament. The project is regarded in the Black Country with considerable favour.

Climate of the British Empire.—*Symons's Meteorological Magazine* for August contains an interesting summary of the climate of the British Empire during 1887. Comparing with the summary for 1886, Stanley, Falkland Isles, takes the place of London as the dampest station. Adelaide has the highest shade temperature, 111°·2; the highest temperature in the sun, 164°; and is the driest station. Winnipeg has the lowest shade temperature, 42°·7, and the greatest yearly range, 135°·9. Bombay has the greatest rainfall, and Malta the least, and also the least cloud. Although the maximum shade temperatures in Australia exceed those in India, the average maxima of the latter far exceed those of Australia.

A Famous Meteorite.—We learn from *Science* that the famous Bahia or Bendego meteorite, described by Morney and Wollaston in the Philosophical Transactions of 1816, and by Spix and Martins in their "Travels in Brazil," was landed in Rio de Janeiro on June 15, and is now in the collection of the Brazilian National Museum. The transportation of this great mass of iron, which has been found to weigh 5,361 kilogrammes, was rendered possible by the recent completion of a line of railroad passing within 115 kilometres of the Bendego Creek, where it has lain since the unsuccessful attempt to remove it to Bahia in 1785. After about three months spent in preparing material and in studying the route to be traversed, the march began on November 25, 1887, and the meteorite was placed on the railroad on May 14 of the present year.

Specific Heat of Gases.—M. H. Le Chatelier finds from the determinations of Wiedemann—*Zeit. physikal, Chem.*, 1,456—that the specific heats of gaseous substances may be represented within the limits of experimental error by the equation $C = 6{\cdot}8 + a\,(273 + t)$ for temperatures below 200deg., where C is the true specific heat at constant pressure, and a a coefficient depending on the nature of the gas, and having a higher value the more condensed the molecule. From this it would follow that as the temperature approaches the absolute zero, the molecular heats of gases and vapours would more and more approximate to the same limiting value, but in how far this may be considered a true law the experimental data are insufficient to determine. From the author's own experiments,, he finds that the relation holds good for carbonic anhydride at 2,000deg., but for water-vapour at 3,300deg. it no longer holds, probably owing to partial dissociation having already occurred.

The Cost of Electricity.—In his paper on "Electricity," read before the Mechanical Science Section of the British Association meeting, Mr. Preece stated that electricity can now be produced by steam at 3d. per kilowatt per hour, the kilowatt hour being the Board of Trade unit as defined by the Act of 1882, for which the consumer of electric energy has to pay. Its production by gas engines costs 6d. per kilowatt hour, while by primary batteries it costs 3s. per kilowatt hour. The Grosvenor Gallery Company supply currents at 7¼d. per kilowatt hour; a 20-candle power lamp, consuming three watts per candle and burning 1,200 hours per annum, expends 82,000 watt hours or 82 kilowatt hours, and it costs, at 7¼d. per unit, 50s. per annum. If the electricity be produced on the premises, as is the case in the Post-office, in the House of Commons, and in many large places, it would cost 20s. 6d. per annum. Mr. Preece states that from a comparison of the general average under the same circumstances, and for the same light in the General Post-office in London, he has found that an electric glow lamp costs 22s. and a gas lamp 18s. per annum. The actual cost of the production of one candle light per annum of 1,000 hours is as follows: Sperm candles, 8s. 6d.; gas (London), 1s. 3d.; oil (petroleum), 8d.; electricity (glow), 9d.: electricity (arc), 1½d.

SELECTED PATENTS.

APPLICATIONS FOR LETTERS PATENT.

August 31st.

12526 Nails, G. Hookham, Birmingham.
12528 Shuttle Relief Motion, R. Hargreaves and E. Edge, Manchester.
12530 Gas Engine, A. H. Parkinson, Manchester.
12531 Cranes, R. F. Mills and T. Savage, Sheffield.
12539 Slubbing Intermediate and Roving Frames, J. Wood, Halifax.
12544 Pipe Connections, J. H. Lyon, Hampshire.
12545 Steam and Water Drums, J. Mills, Manchester.
12550 Tubular Lanterns, G. Barker, Birmingham. (L. R. King, United States.)
12551 Brakes, P. Evans, Liverpool.
12555 Duplex Rivet or Nail, A. O. Grove, London.
12561 Valve Link Motion, T. J. Gibson, London.
12579 Valves and Valve Gear, J. T. Halsey, London.—[Complete Specification.]

September 1st.

12585 War Ships and Batteries, R. W. Hewett, Birmingham.
12587 Fish Plate, G. Slater, Sheffield.
12591 Mules and Twiners, R Curtis and J. Wain, Manchester.
12594 Phonographs, G. E. Gouraud, London. (T. A. Edison, United States.)
12598 Compressing Scrap Metal into Blocks, J. W. Summers and T. Sharp, Manchester.—[Complete Specification.]
12599 Steam Jet Pumps, J. Page, Manchester.
12600 Fasteners for Belts, J. G. Rollason, Birmingham.
12601 Wire Holders, W. Parnall, Bristol.
12602 Life Protectors, D. Gardner, Birmingham.
12613 Power Gearing, T. Scott, Middlesex.
12617 Doubling Frames, T. H. Fallows, London.
12623 Portable Drilling Machines, R. A. Baillie, London.
12624 Separating Drawn Tubes from their Mandrils, W. Lorenz, London.
12627 Rolls, A. W. H. Collard, London.—[Complete Specification.]
12629 Die, J. F. Kingsley, London—[Complete Specification.]
12637 Mechanism for Operating Self-closing Lifting-valves, E. Körting, London.
12639 Lathes, F. A. Dwyer, London.

September 3rd.

12650 Uprights, M. Priestley and J. Priestley, of the firm of M. Priestley and Co., Bradford.
12653 Vessels, G. A. J. Schott, Bradford.
12654 Cutting Out and Piercing Tools, W. Corder, of the firm of Corder and Turley, Birmingham.—[Complete Specification.]
12657 Engines, J. A. Rowe, North Shields.
12658 Pulveriser, T. Williams, Helston.—[Complete Specification.]
12663 Bending or Coiling Tubes, J. Newton and D. A. Quiggin, Liverpool.
12664 Racking Cocks or Nozzles, H. Haddow, Edinburgh.
12665 Revolving Flat Carding Engines, W. Mercer, Manchester.
12671 Steam and Water Valves and Seatings, E. A. Sandford and H. Sandford, Gravesend.
12674 Looms, H. Holden, W. Gregson, J. Myerscough, R. Myerscough, and C. O'Neill, London.
12675 Hoist, F. D. Butler, Middlesex.
12677 Ball Taps or Valves, J. B. Smith, London.—[Complete Specification.]
12680 Buffers for Railway Carriages, J. T. Goodfellow, London.
12695 Ring-spinning Machines, C. H. M. Hamel, London.
12699 Ball and other Valves, O. Elphick, Doulton and Co., Surrey.
12703 Voltaic Battery, G. T. Jolland, London.
12705 Transmission of Power, O. Krell, Middlesex.
12708 Metal Laths, E. Nunan, London.
12710 Furnace Bars, A. Vogt, London.
12711 Boilers, I. S. McDougall and J. T. McDougall, London.

September 4th.

12716 Screw Threads, C. D. Rogers, Manchester—[Complete Specification.]
12718 Feeding Mechanism, C. D. Rogers, Manchester.—[Complete Specification.]
12724 Hoists or Lifts, D. W. Chadwick, Bradford.—[Complete Specification.]
12730 Screw Propeller, C. Forrest and C. Myers, Manchester.
12734 Wood Screws, C. D. Rogers, London.—[Complete Specification.]
12735 Hammers, C. D. Rogers, London.—[Complete Specification.]
12737 Planimeter, H. S. H. Shaw, Bristol.
12738 Steam Traps, W. Hartcliffe and W. H. Malkin, Manchester.
12742 Engines, C. S. Young, Birmingham.
12743 Metallic Packings, T. Downie, Liverpool.
12745 Heating Die Vats, H. T. Everist, Kidderminster.
12757 Railway Rails, E. N. Higley, London.—[Complete Specification.]
12758 Saws, H. H. Lake, London. (G. Montague, United States.)—[Complete Specification.]
12760 Pulley Blocks, A. M. Grimond, Dundee.
12761 Dynamo-electric Machines, A. G. Waterhouse, London.—[Complete Specification.]
12762 Hoisting Appliances, C. F. Amos, Hull.
12765 Metallic Ring-packed Piston Rods, &c., W. Darguc, Halifax.
12771 Die, R. C. Robinson, London.—[Complete Specification.]
12773 Machinery for Drilling, &c., J. Binko and T. Hulbert, London.
12780 Perforated Plates, E. S. T. Kennedy, London.—[Complete Specification.]
12781 Metal Tubes, J. P. Kennedy, London.—[Complete Specification.]
12782 Stop-motions for Looms, H. Butler, of the firm of Butler, Holliday, and Co., London.
12791 Indicators, T. Mudd, Liverpool.
12792 Steam Engines, T. Mudd, Liverpool.
12794 Machines for Twisting Twines, W. Myers, London.
12798 Electrical Sounding Apparatus, P. Vigil and J. N. Revueltas, London.
12799 Pumps, H. J. Wells, London.
12800 Steam Boilers, G. F. Nilsson, London.—[Complete Specification.]
12801 Sheet Metal Shears, H. Pattison and R. B. Dakin, London.—[Complete Specification.]
12802 Dough Brakes, P. Pfleiderer, London. (Messrs. Werner and Pfleiderer, Germany.)—[Complete Specification,]

September 5th.

12809 Railway Line Joints, W. B. Thompson, Dundee.
12817 Electric Engine Stopper, E. Dixon, Hull.
12818 Shaft Couplings, P. Evans, Liverpool.
12829 Locking Nuts, J. H. W. Laverick and E. Farnsworth, London.
12838 Rock Drills, R. Stephens and W. C. Stephens, London.
12842 Axles, P. Leigh Le Duc, London.
12857 Gauges, E. S. Hough, London.—[Complete Specification.]
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EDITORIAL NOTICES.

All communications for the Editor of this Journal should be addressed to 6, Victoria Station Approach, Manchester.

Communications intended for insertion in the current week's issue should reach us not later than Tuesday Evening.

We cannot undertake to return rejected manuscripts or drawings unless accompanied by a stamped and directed envelope.

Contributors are requested to write on one side only of the paper. Sketches should be sent on separate sheets.

TO ADVERTISERS.

Advertisements intended for insertion in the current issue should reach us on Wednesday morning at the latest.

THE
PRACTICAL ENGINEER.
SEPTEMBER 21st, 1888.

TECHNICAL EDUCATION.

LORD ARMSTRONG'S CRITICS.

Lord Armstrong's article on "The Vague Cry for Technical Education," in the *Nineteenth Century*, for July last, will be fresh in the memory of our readers. It was an attempt to appraise at its true value the movement in favour of technical education, about which we now hear so much, and Lord Armstrong very clearly proved that existing schemes for such education will not benefit those in whose supposed interest they are organised, viz., the working classes—"the hewers of wood and drawers of water." He considers that the number of persons who would be benefited in business by such education would be very small, and that existing facilities, which might also be supplemented if necessary, are sufficient for these. He considers that where a man fails to get on in the world, it is not from want of knowledge so much as from want of natural capacity, and of zeal, energy, &c.; and that a person who possesses these will surmount all difficulties in attaining necessary knowledge. He has no faith in technical knowledge saving our trade from the effects of foreign competition, but holds that cheapness and superiority combined will decide the victory here. The whole argument, read aright, is not one calling in question the supreme value of education for those who are able to benefit by it, but is a protest against such schemes as those which we briefly noticed in our leading article on August 31. For thus stating his convictions he has been sharply assailed, first in *Nature*, of August 2nd, and now in the current number of the *Nineteenth Century*, by Sir Lyon Playfair.

Nature alludes to the article as an "unfortunate exposition," and speaks of the writer himself as "a true representative of that remarkable genius, the 'practical' Englishman, who undoubtedly has been the glory of his race in the past, but threatens to be its destruction in the near future." Yet only two paragraphs further on our contemporary admits how vague is the cry for technical education, and adds: "The work has fallen almost entirely into the hands of philanthropists and politicians, and inquiries into the subject have been handed over to men whose qualifications for the work, in too many cases, would have been regarded in any other country but England as lamentably insufficient." We should imagine, then, that these "philanthropists and politicians," and not the "practical Englishman," menace our trade in the near future.

Sir Lyon Playfair accuses Lord Armstrong of throwing "a dash of cold water on the warm efforts which are now being made to promote technical education," and adds: "When I emerge from Lord Armstrong's douché of cold water, I look in vain for some palpable differences between us. All that he recommends the promoters of technical education recommend also."

If Lord Armstrong has misunderstood the position of the advocates of technical education, that is their fault, not his. The extreme vagueness of the cry is generally admitted. We have sought in vain in the publications of the "National Association for the Promotion of Technical Education" for some authoritative expositions of its meaning which should commend themselves to our suffrages. Omitting the various private efforts made by collegiate institutions and technical schools, the only authoritatively formulated schemes are those of the Government bills recently noticed. There is no misunderstanding these, and doubtless Lord Armstrong had these in his mind when he penned his attack. An eminently "practical Englishman" like Lord Armstrong is not at all likely to regard these with favour. Manufacturers may well be jealous and hold aloof from the proposed introduction of such methods as substitutes for what *Nature* calls the "now effete" apprenticeship system. If the Government authorities—the "philanthropists and politicians" of our contemporary—have nothing better to offer us, they had better leave these matters to private enterprise as heretofore.

Moreover, bearing in mind the blundering and inefficiency displayed before all the world by the naval and military departments, manufacturers are the more unwilling to commit so vital a matter as the technical training of our workmen to a Government department. Since it appears evident to all except Government officials that we have lost military and naval supremacy, we should be all the more chary of entrusting our manufacturing supremacy into their hands. By all means let us give due attention to the training of our artisans, but we prefer in this to follow the safe leading of Lord Armstrong rather than that of his scientific critics.

There is one specious argument made use of by Sir Lyon Playfair which we have repeatedly seen before, and it is this: Referring to the present minute division of labour, he makes that a reason why an intelligent acquaintance with an entire industry should be acquired by the "hands" whose duties are confined to a minute section of the same. There is, of course, no objection to this in the abstract, but we protest against the conclusion usually drawn therefrom, that it will prove a means of advancement to the *workman himself.* Machine caretakers are, and must remain, mere "hands," spite of general culture, because the number of men required to *lead* is of necessity very limited.

Of the other great classes into which our operatives are divided, Sir Lyon Playfair says: "It is only the skilled workmen who, in the present keen competition of the world, can obtain high wages; they are cheap at the price, because they bring a trained intelligence to bear upon their powers of production." But we utterly deny the capability or tendency of technical instruction bills to produce skilled workmen. These are altogether the product of the shops, and they perform their tasks so well by virtue of the skill which comes of doing the same thing over and over again.

That Lord Armstrong is not opposed to education as such scarcely needs assertion. We need only point to the existence of the science school in connection with the Elswick Works, the only school of the kind in the kingdom, so far as we know, except that at Messrs. Mather and Platt's, of Salford. It is in such schools, where theory and practice are not divorced, and where teachers are men engaged in the workshops, that the problem of technical education will be finally solved—certainly not by the operation of such bills as those which have been recently introduced.

RAILWAY TRAFFIC IN 1887.

The amount of capital invested in railways in the United Kingdom is so enormous, exceeding as it does by a very large amount the whole of the National Debt, that the financial condition and prospects of the railways may be taken as a fair indication of the state of trade generally. It is pleasing therefore to note from the Board of Trade Report dealing with the capital and earnings for the year 1887, that the income and expenditure shows a decided improvement over that of the previous year. From the report it appears that the total amount of paid-up railway capital at the end of 1887 was £845,972,000, whilst the gross and net earnings were larger during the last twelve months than in any previous year. The average dividend paid on ordinary capital in 1887 was slightly over 4 per cent, while in 1886 it was rather less than 4 per cent. This improvement, it is true, is but slight; but taken in conjunction with the other indications of reviving industry which have been making themselves manifest within the last few months, it may be regarded as an encouraging omen, and as additional evidence that we are at last emerging from the cloud of commercial depression which has hung over us for so long a period.

On looking into the report, it appears that no less a sum than £17,628,000 of new capital was invested in railways during the year, this being larger than that shown in any of the preceding five years. The gross receipts for the year amounted in all to £70,900,000, being an advance of £1,300,000 over the corresponding figures for 1886. Of this amount £1,000,000 was due to improvement in the goods traffic, and the remaining £300,000 to improvement in the passenger traffic. The increase shown in the goods receipts is specially interesting, as this traffic accounts for rather more than one-half of the entire receipts of the year.

The statistics with regard to the ratios of the various classes of passenger traffic are of interest, and illustrate rather markedly the democratic tendencies of the age. The reduction in first and second class traffic still continues, though it is with regard to the first-class that the falling off is most noticed. This of course is no new feature, and the change has been going on steadily for the last ten years. Nevertheless the figures are somewhat startling. The "first-class" receipts in 1877 on the English and Welsh railways was £3,669,744, whilst in 1887 it only amounted to £2,541,431. A similar contraction in the "first-class" traffic is visible in Scotland, and more still in Ireland. In "third-class" passengers the movement has everywhere been in an upward direction; and if we take the United Kingdom as a whole, the receipts from this class have gone up from nearly £14,000,000 in 1877, to upwards of £18,000,000 in 1887.

ERRORS IN CONSTRUCTION.

Girder and Arch Bearings.

There has been much difference of opinion in the matter of designing the bearings for girders and arches, but these elements of structures have duties quite as clearly defined as those of other details. The bearings have to sustain the whole weight of the structure and load, and, in addition, must be so constructed as to allow for alterations in length and position, due to variations of temperature, and the effects of deflection or distortion under passing loads. It is customary to provide for actual extension and contraction by placing the girders, if of short span, on sliding plates, and if of long span on rollers. The actual span at which the sliding plates should give place to rollers depends upon the locality as influencing extent of variations of temperature, and to some extent upon the construction of the girder. The writer knows of girders of 90ft. span carried upon sliding plates, which have given no trouble, but some engineers insist upon rollers under all girders upwards of 30ft. span. No doubt they must be some drag upon the piers when sliding plates are used, so that in settling this point the materials and workmanship of those parts of the structure must be considered. For instance, the sliding plate may be quite admissible when the pier or abutment is properly built of solidly-bonded stone; but on an ordinary brick pier it would not be suitable, and might lead to the cracking of the brickwork. In an arched structure the expansion and contraction must cause alterations in the form of the arch, for there can be no allowance made for longitudinal movement, as the abutments have always to sustain the thrust of the arch. We now come to the question of distortion, caused by a passing load. When a girder is deflected its ends will be canted up, so that if it is carried on a horizontal surface, the pressure will come wholly on the front edge of the bed plate, unless some provision is made for its proper distribution in all positions. The extreme amount of movement is found by calculating the radius of curvature of the girder when fully deflected; if the plates in flanges are properly distributed, the girder when loaded will assume, very nearly, the form of a circular arc, then the amount of lift at the end of the bearing plate will be to its length as half the span of the girder is to its radius when deflected. To find the radius of curvature,

Let $L =$ length of girder before deflection;
$d =$ depth of girder; and
$l =$ difference in length of top and bottom flanges after deflection, all in feet.

(l will be found from the ratio of the strains per sectional square inch on the flanges to the modulus of elasticity, which for single web-plate girders is 6,400 tons.)

If $R =$ radius of curvature; $R = \frac{d\,L}{l}$; and at the Board of Trade limit of 5 tons per sectional square inch, this will become $R = 640\,d$; for the extension of the bottom and compression of the top flange is $\frac{5\,L}{6{,}400}$, and $l =$ the sum of the extension and compression, therefore $l = \frac{2\,L \times 5}{6{,}400} = \frac{L}{640}$, and replacing l in the previous formula by this value we have :—

$$R = \frac{d.L}{l} = d.L \div \frac{L}{640} = 640.d.$$

We will take as an example a bridge of 30ft. span, having a mean girder depth of 3ft., and length of bearing plates 1½ft. The radius of curvature under maximum strain will be $R = 640.d =$ 1,920ft.; and calling h the lift at the back of the bearing plate, $h : 1{\cdot}5$ as 15 (half span) : 1,920; or $\frac{h}{1{\cdot}5} = \frac{15}{1{,}920}$ and $h = 0{\cdot}012$ft. = 0·144in. as a maximum. A very small disturbance such as this may be taken up by setting the bottom or bed plate upon layers of felt, which will yield, and so distribute the pressure evenly over the bearing. If this is not done, the pressure will come on the front of the bed plate, or, where rollers are used, on the front roller, and in each case, instead of a fair bearing surface being presented, there will be only a narrow strip, little more than a line of contact.

If the lift is too much to be taken up by felt, a different construction must be used. The bearing plates fixed to the bottoms of the girders should not rest directly upon the bed plates carried by the piers, nor upon the rollers when these are used, but upon an intermediate plate, having across the centre of its length a semi-cylindrical raised part, upon which fits a cylindrical concavity in the bearing plate or saddle attached to the underside of the girder; then, however the girder may deflect, the pressure on the bearing plate is always equally distributed by the action of the saddle, which oscillates upon it in obedience to the angular variations at the end of the girder.

One error to which we allude occurred in a rather large bridge made for one of the colonies. The bearing plate was made convex, so that it could roll upon the bed plate, which had a horizontal surface. The bridge was designed to carry 80 tons, so that when loaded there is, with its own weight, about 25 tons on each of the four bed plates, and from its construction there can at no time be much more than a line of contact between the bearing and bed plates, so that the pressure per square inch must be enormous.

The second class of error is the same in principle, but occurs in an arched iron bridge, where allowance for altering form should be provided by a rounded end playing in a suitably formed socket. In the instance in view, the ends of the arch were made concave to a large radius, and the abutment plates convex to a rather smaller radius; so here again there is little more than a line of contact. In both these cases the actual width of the very narrow bearing will be determined by the amount of compression on the surfaces of contact necessary to equipoise the pressure upon them. We particularly point out these errors in *existing structures* so that young engineers may not be led inadvertently to copy them.

LARGE HYDRAULIC PRESS.—The huge hydraulic press for the manipulation of heavy forgings erected at the Grimesthorpe Works of Messrs. C. Cammell and Co.—Cyclops establishment—is now in satisfactory operation. It is nominally capable of exerting a pressure of 4,000 tons, with a capacity of working up to 5,000 tons.

UNITED STATES MINERAL STATISTICS.—From the official report of the United States Geological Survey, it appears that the aggregate value of the mineral productions of the United States, in 1887, was the largest ever reached by the mineral industries of any country, the total value being given at upwards of 538 million dollars, and nearly 73 million dollars more than the production of 1886. Of the many items which make up the total, all the metals increased in quantity except gold and the minor metal nickel, and nearly all increased in price. The following are some of the more important items of production: Pig iron, 6,417,148 tons; silver, 41,269,240oz. troy; gold, 1,596,500oz. troy; copper, 184,670,524lb.; lead, 160,700 short tons (2,000lb.); zinc, 50,340 short tons; coal of all descriptions, 123,965,255 short tons; petroleum, 28,249,543 barrels of 42 gallons each.

THE FORTH BRIDGE *

(Continued from page 441.)

Riveting.—The riveting of the bottom members of the cantilever, of the vertical columns, and of portions of the diagonal struts between them, has been executed by hydraulic riveters of special design, the principle of which has been to use independent rams for the holder-up and the snap. The holder-up could be traversed along a girder usually pivoted so as to revolve on the axis of the tube, or with its ends moving in a race, so that the girder moved round the tube parallel to its axis. In both cases the holder-up preserved its direction normal to the surface. The snap was fixed in a ram which also could be traversed along a girder, the latter being movable parallel to the axis of the tube, with its ends travelling in slots formed in rings surrounding the tube. By this arrangement of motions both holder-up and snap could deal with every rivet. The operation of riveting was as follows :—The rivet, properly heated, was placed from the inside into its hole, the holder-up was brought opposite to it, the valve admitting the water was turned on, the holder-on thrust the rivet in up to the head, and held it there, whilst the ram on the outer girder closed the rivet, the same valve admitting water to both rams, but a slight check in the branch leading to the outer ram permitted the rivet to be sent home by the inner ram before the pressure was applied to form the snap. About 800 rivets could be closed by this apparatus in ten hours.

The bed-plates, both upper and lower, were riveted by similar apparatus, but simplified, inasmuch as plane surfaces only had to be dealt with. For the interior parts of the skewbacks, where the space was too confined for hand-riveting, or for the use of rams of ordinary size, special rams of small size. 4in. in diameter, were used as holders-up and snaps, the necessary power being obtained by multiplying the ordinary pressure of 1,000lb. about six times, by the use of an apparatus fitted with rams 4in. and 10in. diameter. Grab machines of various patterns were designed and made by Mr. Arrol for the riveting of the top members, for the ties, and for parts which could be reached by this form of riveter.

Mr. Arrol has also greatly simplified the subject of riveting by designing and constructing small reverberatory furnaces for heating the rivets by the blast-furnace residual oil, delivered in a fine spray by air at about 20lb. pressure, through a disintegrator of special design. This has been a great success. The regulation of the heat is complete, the rivets are uniformly heated, the apparatus is more economical than hand fires, and is under perfect control. It is also cleanly, and the danger from fire is much reduced. A small furnace, 1½ft. square and 4ft. long, will heat 2,000 rivets per day, at a cost for oil of about four shillings.

As the material used in the construction of the Forth Bridge is of special interest to the Iron and Steel Institute, I may be permitted to say that the experience gained by the manufacture of nearly 50,000 tons of Siemens-Martin steel work, enables us to say that nothing could be better than its behaviour. Plates and bars have been obtained from several distinct firms, and in every case the utmost uniformity has been found, and any variation has been in the direction of improved ductility. Where 20 per cent elongation has been required, 25 per cent has, as a rule, been obtained, and in the harder material it has been increased from 17 to 20 and above without any difficulty. The cold bend tests are marvellous, as the specimens exhibited show. The analyses made in the course of manufacture of the steel show that the proportions of the different principal components are generally as follows :—

	Thirty to Thirty-three Tons per Square Inch.	Thirty-four to Thirty-seven Tons per Square Inch.
	Difference per Cent. Iron	Difference per Cent. Iron
Carbon.............	·19	·23
Silicon.............	·02	·03
Sulphur	·024	·024
Phosphorus	·046	·046
Manganese........	·69	·69

It is hardly necessary to remind you that Sir John Fowler and Mr. B. Baker are the engineers of the undertaking. They have furnished designs with great minuteness of detail for every part of the permanent structure, and have personally supervised the manufacture and erection, the methods made use of in the latter having been considered and advised upon by them. Mr. Arrol is the responsible representative of the firm of contractors entrusted with the work, and he has arranged for and carried out the manufacture of the steel work, including the design of the numerous special machines, such as multiple drills, bending presses, and others necessitated by the large amount of material to be dealt with, as well as the various apparatus and machines described in this paper as employed in the erection. He has in all these been ably assisted by his engineering manager, Mr. A. S. Biggart, A.M.I.C.E.

On the conclusion of the paper an interesting discussion took place.

The first speaker was Sir Lowthian Bell, but he merely rose to introduce to the meeting Mr. T. G. Clark, of New York, who, the speaker stated, was one of the leading authorities in America on the science of bridge construction.

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* Paper by Mr. F. E. Cooper, M. Inst., C.E., read before the meeting of the Iron and Steel Institute.

Mr. Clark, in response to the invitation to speak, said the work of the bridge was of such a novel nature, and so different from anything which had ever been done before, that he felt an extreme modesty in giving an opinion upon it. There were one or two points, however, on which he could speak with certainty. Firstly, the bridge not only looked strong, but it *was* strong. It carried to the eye that appearance of stability which every large bridge ought to possess, and they would see that it was a bridge that no wind, no gale, no tornado could upset. It constituted, in fact, a great object lesson in permanent stability.

The bridge was also admirably adapted to support its own vast superincumbent weight and the moving load. All the compression members were tubes, whilst the extension members were lattice girders; thus showing how just an appreciation its creators had of the best disposition of material to the work to be done. Like all great engineering designs this was notable for the simplicity and harmony of its parts. All was arranged in a plain common-sense manner. When a strain had to be taken it was carried directly to the part designed. There was no crossing to and fro, no development of zig-zag courses to absorb material needlessly. There was a concentration of material along the lines of strain, and large parts were used by which less surface was exposed to wind pressure; wind pressure, it must be remembered, being calculated at double the strain of the train load, supposing the bridge were covered from end to end. Another point of novelty in the building of this bridge was, that the engineering shops for its construction were brought to the site of the bridge; but this was desirable, if not altogether necessary, from the magnitude of the work to be done.

Speaking of the method of construction Mr. Clark said that the formation of the joints of the enormous tubes had always been looked upon in America as one of the great difficulties in carrying out the work. He, for one, had wondered how this was going to be done, but when he came to the works and saw how clearly all the arrangements had been made—how models were constructed, parts prepared and fitted, all so harmonious and well ordered—the difficulty was no more existent than when Columbus stood the egg on end. It was the old story of the simplicity of genius triumphant over difficulties. Another point that had exercised his mind was the manner in which the central girder was to be put in place between the two overhanging cantilevers; but here again there was simplicity where confusion might so possibly have intruded. The sliding joints which would allow for expansion and contraction in the finished structure were to be temporarily made rigid, and the girder would just be built out from each end as an extension of the cantilever until the two parts met in the middle, when they would be joined up and the sliding joints relieved. He wished to endorse the high terms in which Mr. Cooper had spoken of the material. In this steel they had not only a metal of great strength and endurance, but also one of complete uniformity. There was one point in constructive practice, however, in which there was a difference between English and American methods. In his country they were not in the habit of drilling steel as in Britain, but punched their holes and then rimered them after. This practice afforded an excellent inspection of the material. He considered a plate that would not bear punching should not be incorporated in the structure, and he looked on a punched and rimered hole as being as good as a drilled hole. Returning to a consideration of the bridge as a whole, the speaker said, that when completed it would be found to be a great architectural creation. Until it was stripped of its scaffoldings and stagings no definite opinion could be formed of this aspect of the design, but architectural beauty could not otherwise than exist in a structure so simple and so harmonious. It was true it possessed no ornament constructive or designed. Neither did the Pyramids of Egypt: and they wanted none.

Mr. Wrightson, of Stockton, pointed out that the leap forward in bridge designing which was exemplified by the structure which was so soon to span the Forth was very remarkable, and its creation would mark an epoch in this branch of engineering. The East River Bridge in America, which joined New York to Brooklyn, approximated to it in height and span, but in that there was simply an extension of the well-known suspension principle. He believed there was no cantilever bridge above half the span of that now under discussion. If the carrying out of the construction were not in the hands of those who were so well known to thoroughly understand it, the public might perhaps have doubted whether the work were possible; but, as it was, there could be no question that all promises would be fulfilled. He had gone very thoroughly into all details, and had the greatest possible confidence in the success of the plans. A point that was worthy of notice was that the contractors had carried out the erection without unduly straining the material as it was worked into the structure. The top member of the cantilever was doubtless the most difficult part to deal with in this respect, and an enormous amount of calculation had been required to work the problem out. Yet the ultimate limit of 6½ tons had never been exceeded at the end of the cantilever, for it must be remembered that until the top member was joined to the cross supports it was itself a cantilever.

Mr. James Riley, of the Steel Company of Scotland, next rose at the invitation of the President. He said that at first they had had a good deal of anxiety in respect to the material, but this had soon disappeared as the work went on, the more quickly, perhaps, because they had been treated with such kindness and leniency by the contractors. Not, indeed, that there had been great occasion for leniency, for he could honestly claim that their material had always stood the test required, but he was glad to be able to acknowledge the liberal and kindly appreciation with which all their efforts to produce a steel suitable for the work had been met.

The President next invited Sir Lowthian Bell, as a director of one of the contributing railway companies, to add something as to the financial aspect of the undertaking.

Sir Lowthian Bell, in response to this invitation, said that at present the financial aspect of the question was involved in obscurity; but none, he thought, were sufficiently sanguine to suppose that the mere passage of trains across the bridge, and the fares received from passengers for that section of their journey, would afford an adequate return for the money now being expended. But there were other and wider considerations to be taken into account, and the advantages that would accrue to the lines in connection with the system, of which the Forth Bridge would form a link, were such as would fully warrant the sinking of the money.

Mr. Adamson, in summing up the discussion, said that everyone present knew he had had great experience in structures of iron and steel, and he must congratulate the members of the Iron and Steel Institute on the regularity of the mild steel of which the Forth Bridge was constructed. Analysis proved that it was a material that could be depended upon, and he would indorse all that Mr. Clark had said except upon one point. He (Mr. Adamson) considered that a man who destroyed a good steel plate by punching it deserved to be punched himself. Steel was now beyond the stage of wanting to be tested by punching, and the proper way to ascertain its qualities was by analysis. He had often told the members of the Iron and Steel Institute that silicon, phosphorus, and sulphur should be kept low in such material, and referring to the details given in the author's paper, this would be found to be borne out. He considered it wise that the strengthening elements, carbon and manganese, should be high whilst the undesirable elements were kept down.

Mr. Henning said that he had been engaged in the erection of many steel structures in America, amongst them the East River Bridge, and he wished to say, in reference to Mr. Clark's remarks, that he had always advocated drilling rather that punching holes—in fact, the former was looked on as the best practice in the United States.

Mr. Clark explained that when speaking of punching he referred to a milder steel than that used for the Forth Bridge.

In replying to the discussion, Mr. Cooper said he was also of opinion that it was bad to punch holes in steel plates, and he would further add that a bad effect was produced on the material by the action of shearing. It was true they did shear the plates used for the Forth Bridge, but then they always planed the edges after, and most of the plates were delivered to the required size. As a matter of economy in working, moreover, he could not see that punching and rimering was as cheap as drilling, for they would drill five or six plates at once. At times, however, when drilling overlapping parts, the drill would not go just where it ought to, and then they were obliged to have recourse to the rimer. Their experience in this respect was quite enough to teach them to avoid the use of that tool as much as possible, and they would always far rather drill at one operation than punch and rimer in two operations. With regard to the strain, upon which a question had been asked, the speaker said that the total strain of dead load, live load, and wind, was 6,000 tons; the dead load was 2,282 tons, and the live load 1,022 tons, whilst the wind pressure accounted for the rest. It would therefore be seen how important a factor the wind pressure was in making the calculations, and the effect of this would be seen in the design of the structure. Looking down the length of the bridge, it appeared a network of material, so that a rifle-bullet could not be fired down without hitting some part. A view crosswise was, however, quite different, for it was quite open in design, thus allowing free passage for the wind blowing up and down the river. Mr. Wrightson was quite right in saying that the great difficulty was in erecting the top member, and there was an enormous strain set up as it grew outward in the process of construction. The shearing difficulty would not be present in the finished structure, and it was got over during the building by temporarily doubling the parts most subject to strain, the extra material being removed when the member was carried out to meet the supporting parts. He had followed with interest what had been said about the material used for construction. A bridge on the same plan had been built near the Niagara Falls in America, and although commenced after the Forth Bridge, it was finished first, being a smaller and more easily constructed structure. The American engineers, however, had not the same faith in mild steel that was possessed by their English brothers, and they seemed to think that steel plates were hard in one corner and soft in another, whilst they would tumble to pieces if one only looked at them. The Niagara Bridge was, therefore, made of iron, and the Eiffel Tower in Paris was made of iron for the same reason, the French engineers thinking steel not reliable. That quality, however, was exactly the one which mild steel essentially possessed. It was homogeneous; for it had the same structure or composition right through. There were no layers of soft metal with layers of slag of uncertain quantity, as in wrought iron. It was ductile, too, and in confirmation of this the speaker exhibited several specimens and test pieces bent cold, and showing that remarkable ductility which is now recognised as a regular characteristic of the material. He had been asked whether wind pressures were greater at the top of the cantilever than lower down, in answer to which he might say there was very little difference. At Inch Garvie (the small rocky islet in the middle of the Forth which had come in so opportunely and saved such a large amount of expenditure) they had registered an average of 34lb. to the square foot, whilst the wind gauges at the short ends only recorded 12lb. and 22lb. respectively. This shows that the strongest blows came in puffs or flaws, and other records confirmed this; for instance, they had had 19lb. to the square foot on the big board of their wind gauge, and 38lb. on the small one, whilst from another board they had read 32lb. On the big board there were two gauges, and the maximum register for one was 32lb.; this was in the middle, whilst at the corner the maximum reading was 28lb. It was evident, therefore, that a large structure rather than a smaller one was better able to stand against the pressure of heavy winds, for a small span might occupy the whole region of a heavy puff, whilst the mean pressure over a larger area would be considerably less.

Captain Jones, of the Edgar Thomson Steelworks, Pittsburg, was present, and had expressed his desire to add a few words to the discussion. The President, therefore, put it to the meeting whether the ordinary course should be departed from and Captain Jones be heard. The result was that Captain Jones was invited to speak. He said he had not designed to take part in the discussion, but he could not let what Mr. Clark had said about the practice of punching steel plates in America pass without comment. It was a point upon which he (Captain Jones) felt very strongly. Punching steel plates was a relic of barbarism, and it was but logical it should call forth barbaric remedies. There was an appropriateness about the President's suggestion, to "punch a man who punched a plate," but they might find a more neutral form of treatment equally efficacious. Certainly propagation of the species of error involved in punching a steel plate should be stopped in the most effectual manner. As to the relative cost of punching and drilling, he had long since made up his mind about that, for many years ago in constructing a roof he had drilled all the holes, and found it cheaper than punching. With regard to the use of steel in America, they found boiler-makers, bridge-builders, and many others using it largely. They had started with physical tests, not chemical analysis, but they had come to the conclusion that physical tests could be met, and yet the metal not be what it should be. The test for boiler plates at the Edgar Thomson Works was higher than that demanded for the boiler plates of the United States cruisers, the limit for phosphorus being ·035, and manganese ·350 per cent. He had seen steel made in America where the heat had been blown for eight minutes, the manganese being put in cold, and he was of opinion that the reaction had not taken place up to the time of speaking. With regard to steel for bridge construction, he considered that not more than ·065 per cent of phosphorus should be present, and the manganese should be kept low, as that was the great oxidising agent. He would like to see these conditions enforced by law. In conclusion, he wished to impress on his hearers the necessity for judging steel by chemical tests first, and letting the physical tests be subsidiary to them.

Mr. James Riley asked permission to add a few words in reference to what Captain Jones had just said. He could not too strongly express his conviction that it was not the function of the engineer to say what should be the composition of the steel he had to use. This was essentially the province of the metallurgist or steelmaker. The engineer might insist on any physical tests he liked, but he should not dictate how the material should be made. For this reason the speaker entirely disagreed with Captain Jones's opinion that engineers should specify for chemical tests and consider them before physical tests in passing material.

This concluded the discussion, and the President moved a vote of thanks to Mr. Cooper for his interesting paper, which was carried with acclamation.

THE FIRST CENTURY OF THE MARINE ENGINE.—V.

(Continued from page 436.)

Theoretically, a pound of good fuel ought to evaporate 14lb. of water from and at the temperature of 112° Fahr. In practice, only about 8lb. are evaporated, the remainder being wasted in imperfect combustion, in radiation, and above all in creating a draught. The efficiency is, therefore, only about ·6, so that there is still a wide margin for improvement.

Attention will therefore be given to every design which diminishes waste of energy. Amongst the most promising of these connected with the boilers is the introduction of forced draught, to supersede or to supplement the natural draught produced by the funnel. This subject has been discussed before this institution, and is now receiving considerable attention from engineers, and it is to be hoped that sufficient data will soon be presented to the engineering public to enable a definite opinion to be formed regarding it. There can be little doubt, however, but that it is destined to have wide applications in the future.

The surface condenser came into general use at the same time as the compound engine, and no doubt contributed largely to its success. It has not altered much in its design since that date, although recently in many cases its weight has been very much reduced. Time, however, will not allow us to enter into details of boilers, cylinders, and condensers, and of the various appliances connected with them. On these points reference must be made to the papers which have been read before this and similar institutions.

The chief stages in the increase in the pressure of the steam used in marine engines and the consequent improvement in the efficiency have been already mentioned, but for convenience they may be recapitulated. Until about 1830 the pressure seldom exceeded 3lb. on the square inch above that of the atmosphere. From that date a gradual increase took place, and in 1845 the average was about 10lb. on the square inch. By 1850 it had reached about 15lb. In 1856 Randolph and Elder employed pressures of 30lb. in their compound engines, but it was not till almost ten years later that such pressures became general in the merchant service. On the compound engine becoming common, pressures rose suddenly to 60lb., and in some cases 80lb. and 100lb. on the inch, and since 1882 the average for triple-expansion engines has been from 130lb. to 150lb., and for quadruple-expansion engines 160lb. to 180lb.

The ordinary method of measuring the performance of a marine engine is by ascertaining the weight of fuel used per I.H.P. per hour. Watt, in his land engines, is said to have begun with 8·3lb. and to have gone down to 2·7lb.

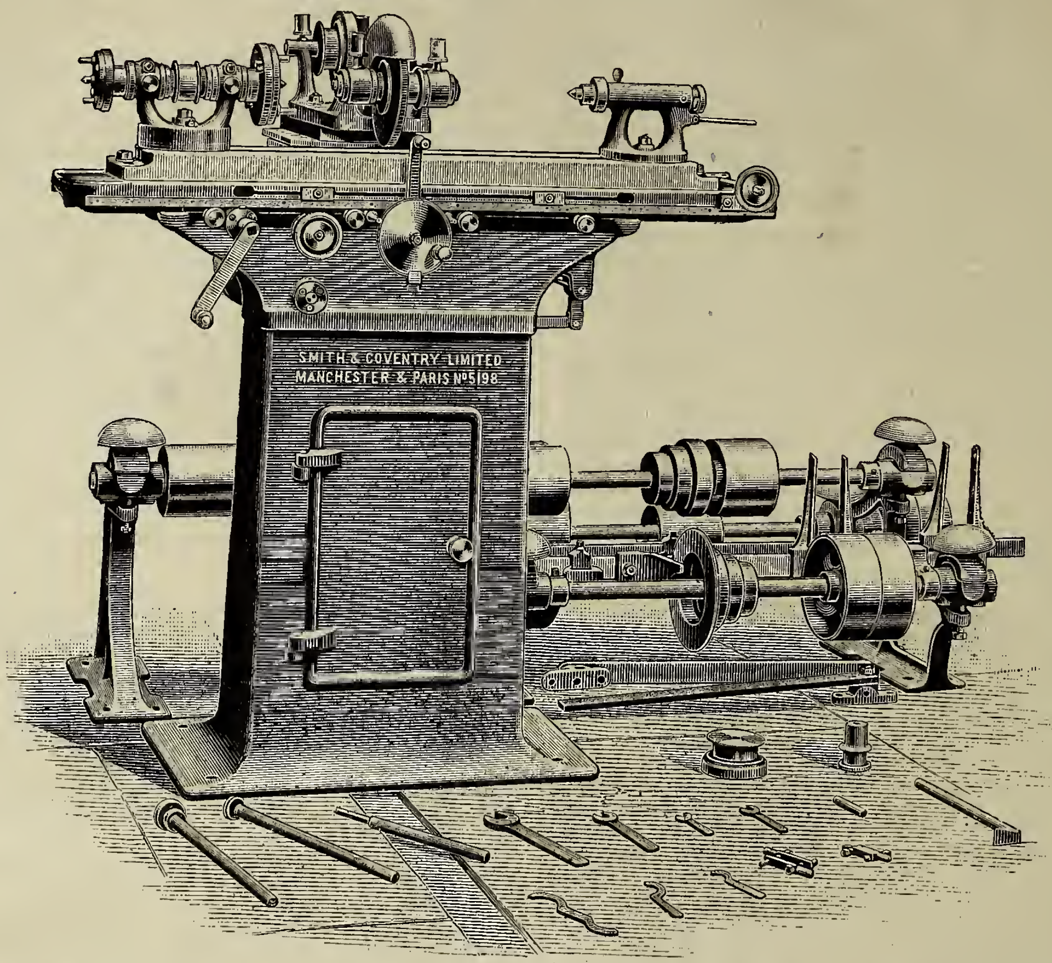
The earliest marine engines must have used 9lb. or 10lb., and the well-known side-lever forms in use for so many years with a pressure of about 10lb. on the square inch are known to have consumed about 7lb. of coal per I.H.P. per hour. For engines in use immediately before the general introduction of the compound type 4lb. to 4½lb. was the average. Randolph and Elder, in their compound engines, had an average of from 2½lb. to 3lb. In 1872, when two-cylinder compound engines had been in use for some years, it was found by Mr. Bramwell that the average of 19 ocean steamers was about 2·11lb., being a saving of nearly 50 per cent on the ordinary engines; and in 1881 Mr. Marshall found the average of 30 steamers to be 1·828lb., or a further saving of 13·37 per cent, while with triple and quadruple expansion engines there has been a still further reduction of about 25 per cent, the consumption in some of those engines being as low as 1½lb. or 1¼lb. of fuel per I.H.P. per hour.

The system of measuring the performance of engines in terms of the consumption of fuel per I.H.P. per hour cannot be considered at all scientific, although it may be convenient for approximate calculations. The quality of fuel varies considerably, and therefore it would be more exact to take instead the number of units of heat imparted to the water in a given time. But for the pressures in ordinary use the problem of obtaining the greatest possible quantity of indicated work from a given expenditure of heat in producing steam is so nearly identical with that of obtaining the greatest possible quantity of work from a given weight of steam, that in practice the difference between the two problems may be neglected. We ought therefore to use as unit of comparison the weight of steam consumed per unit of power given out. The best marine engines of the present day may be set down as consuming 12lb. of steam per I.H.P.

It must be admitted, moreover, that indicated horse power is not a very satisfactory measure of the efficiency of engines, not only on account of the difficulty of ascertaining its value, but because it is only one of the factors of the actual horse power. We might have two engines using the same amount of fuel or steam per I.H.P. per hour, but if the efficiency of the mechanism of the one was much greater than that of the other, the actual horse powers of the two would be very different. The modern marine steam engine is in such a stage of development that the comparison of ordinary compound with triple or quadruple expansion engines is apt to lead to wrong conclusions. We require, in addition, tests of the efficiency of the mechanism, and of this, it must be confessed, we know practically nothing. In the discussion on Mr. Parker's paper, already alluded to, Mr. Seaton mentioned that in two ships alike in every respect, except that the one had two-crank and the other three-crank engines, the result of their performances amounts to this: "That the consumption of coal per I.H.P. is precisely the same, but that the three-crank engine drives its ships half a knot or five per cent faster than the two-crank engine;" and he goes on to say that "he thinks is a very important point, and one which has not been sufficiently dwelt on by marine engineers, because, in discussing the relative merits of the two and three crank engine, it has been practically limited to comparing the consumption of coal per I.H.P. Shipowners do not care so much about that as about the consumption of coal per ton carried, and the speed at which it is carried." Mr. Seaton has no doubt but that the three-

UNIVERSAL GRINDING MACHINE.

CONSTRUCTED BY MESSRS. SMITH AND COVENTRY, SALFORD.



crank engine is superior in every way to the two-crank one, whether it be a quadruple or a triple expansion, because, whether you have the quadruple engine, or the three-cylinder triple, you have all the defects of the two-crank engine, an opinion which confirms what I have already said, and proves the necessity for attention being paid to the performances of the mechanism of marine engines. In every department of scientific investigation progress has been marked by the advance in the methods of measuring the quantities involved. At first these are merely qualitative or relative, and the aim is always to make them quantitative and absolute. It seems to me that engineers have not devoted the attention which the subject deserves to the quantitative measurements connected with marine engines, the full consideration of which, however, is beyond the scope of this paper, and it is merely mentioned for the purpose of pointing out its importance.

Improved valve gears, pistons, bearings, both as regards design and arrangement, the use of separate pumps for feed and circulating water, have all no doubt added to the efficiency of the mechanism of modern marine engines, although the multiplication and special arrangement of parts in some cases may have neutralised this improvement. Again, increased piston speed has led directly to economy of weight, the power developed being proportional to the speed of the piston, and the weight not being affected by the increased speed to any great extent. In the early marine engines from 150ft. to 200ft. per minute were the average piston speeds; now from 600ft. to 800ft. per minute are common, while speeds of upwards of 1,000ft. per minute are not unknown. In order that high speeds may be safely and economically employed, it is necessary that the moving parts should be carefully balanced, the steam passages and ports carefully proportioned, the bearing surfaces ample, and that provision be made for a thorough system of lubrication.

The extended use of steel has been the means of reducing the weights of marine engines and boilers to a very considerable extent, and this is another part of the subject which has not received the attention it deserves, as the weight of the engines and boilers on board a ship has a considerable effect on its commercial efficiency, or the profits it yields to its owners. It is stated that every ton of deadweight capacity is worth, on an average, £10 per annum for freight; that is to say, that every 100 tons saved from the weight of the engines and boilers, without increasing the cost of working, is equivalent to £1,000 a year additional income to the owners. It is difficult to get exact figures showing the relation of weight of machinery, including engines, boilers, water, and all fittings ready for sea, in pounds per I.H.P., but the following* by Mr. Marshall, of Newcastle—who expresses the opinion that the weight of marine engines has not received the attention its importance demands—gives a near approximation :—

	Lbs. per I.H.P.
Merchant steamers	480
Royal navy	360
Engines specially designed for light draught vessels	280
Modern locomotive	140
Torpedo vessels	60
Ordinary marine boilers, including water	196
Locomotive boilers, including water	60

No doubt these figures could be very much reduced if engineers endeavoured to make their designs as light as possible; but here again the commercial element limits their action, for light engines are always expensive, their high-class workmanship and costly material more than balancing the advantages to be derived from reduced weight. In some of the ships which have been recently built for the royal navy considerable reductions in weight have been made, but it is very doubtful if such designs would be found good investments if applied to merchant ships.

There is still another factor in the efficiency of marine engines which time will only allow me to mention, and that is the efficiency of the propeller, the conditions of which, notwithstanding all the ingenuity which has been spent upon them, still to a very large extent remain unknown. No subject has been more discussed before this and similar institutions, and yet Robert Griffiths, who had perhaps made more experiments and worked more at the screw than anyone else, in one of his latest utterances said that "four strips of plate iron set at an angle on the shaft which would hold the engine at the speed you required, would give you within half a knot of the best screw ever made." Mr. Barnaby, in his work on "Marine Propellers," although not prepared to endorse this statement altogether, thinks "it would be safe to say that a uniform pitch screw of the proper diameter and pitch, of the shape finally used in the Archimedes, will give within half a knot of the best screw ever made," so that progress in this department has been relatively small. Mr. Froude showed that only about one-half of the total power exerted by the engines is effective in propelling the vessel, the remainder being spent in overcoming friction and other resistances. In the actual construction of screw propellers, considerable improvement has been made in the materials, for in addition to cast iron, steel and gun metal, as well as various other compositions, are used to a considerable extent, and quite recently various successful experiments have been made, about which the members of this institution are soon likely to be informed.

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* Proceedings of the Institute of Mechanical Engineers, 1881, p. 461.

In modern warships twin-screw propulsion is almost universal, and they can thus be manœuvred rapidly, and in the event of one propeller being injured in action or by accident, the vessel can be propelled, although at a somewhat reduced speed, by the remaining one, while in the event of injury to the rudder, it can be steered by means of the screws. The general adoption of twin screw propulsion in the merchant service, at least in passenger steamers of the largest sizes, is likely to be one of the next steps in advance.

I have already spoken of the necessity of making our knowledge of the efficiency of the mechanism of marine engines more exact by means of carefully-conducted experiments. The same remark applies to our knowledge of the screw propeller. In determining the power necessary to drive a given vessel at a required speed, or predicting the speed with a given power, the engineer and shipbuilder must trust largely to their experience with similar ships and engines. Even when experiments are made with models this is largely the case. The efficiencies of the mechanism of the engines and of the propellers being practically unknown quantities, the required effective horse power is multiplied by a factor which includes both, in order that the gross indicated power may be obtained and the dimensions of the engines calculated—a somewhat empirical process, which shows the necessity for systematic experimental investigation before we can expect much improvement in efficiency.

(To be continued.)

UNIVERSAL GRINDING MACHINE.

The illustration on the opposite page represents a form of grinding machine manufactured by Messrs. Smith and Coventry, of the Gresley Ironworks, Salford, which possesses several novel features that especially recommend it as a tool for an engineer's workshop. The machine is specially adapted for grinding soft or hardened spindles, shafts, rhymers, cutters, trueing out straight or taper holes, or in fact for any of the hundred and one little operations which call for truth and accuracy, and involve the use of some such tool as this.

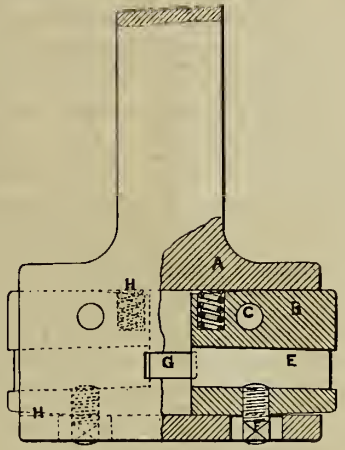
The table of the machine is made sufficiently long to cover the sliding surfaces of the bed on which it rests in all positions, so as to keep it quite free from grit and rust, while the great length of the bearing surfaces practically ensures them against wear. There are two tables, the upper one being pivoted on the lower one, and its revolution controlled by a screw fitted with a graduated index, so that the emery head can be set out of line when grinding articles with a long taper. The table may be traversed in both directions either automatically or by hand, whilst stops are provided so that the length of the stroke may be regulated.

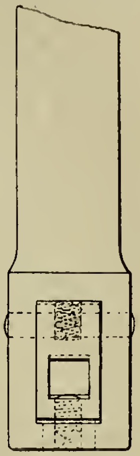
The head carrying the emery wheel is situated at the back of the machine, but its movements are controlled from the front, and it can be traversed in or out at right angles to the centre of the table, and also set at any angle and further traversed while in that position, so as to permit of sharp angles being ground which cannot be reached by the upper swivel table.

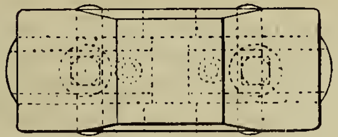
A combined triple top-driving arrangement is supplied with the machine, fitted with the requisite pulleys for connecting to the running heads, the grinding head, and the feed motion, the former being fitted with an efficient brake, for enabling the work to be quickly brought to a stand when required for gauging, &c. The machine is also fitted with a Horton chuck, as well as with five emery wheels and the usual screwkeys. The machine altogether is well and substantially made, and finished in accordance with the usual first-class style for which Messrs. Smith and Coventry have acquired such a well-deserved reputation.

DOUBLE-TOOL HOLDER FOR SLOTTING.

The accompanying illustration represents a form of double tool holder, specially adapted for slotting locomotive axle boxes, where the keeps fit in, and will be found useful for any other kind of work where two surfaces require to be made parallel to each other. It will also be found very advantageous as a single-tool holder, and turn out better work than the one of ordinary construction, which holds the tool fast, and in consequence wears the cutting point at each return stroke, by drawing it across the surface of the work being slotted. On reference to the engravings it will be seen that the block B is fitted tightly in the box, which has been slotted out previously to receive it, after which the pinhole C is drilled right through. The block B is then removed and eased just sufficiently for it to work freely without any play sideways, and the clearance, HH, cut to allow the block B to work on pivot C, so as to relieve the tool at the return stroke. The space E is for the tool, which is secured in position by the set screw F, screwed through the block B. Clearance is allowed in the box for admitting a spanner to the set screw F, and a hole is drilled in the block B to admit a small spiral spring, A, which is just sufficiently strong to force the block B up solid against the top of the box after the return stroke. The slot G is for forcing the tool or block B out when required.







AN ENGINEER'S LIFE AT SEA.—XIV.

BY A SEA-GOING ENGINEER.

(Continued from page 429.)

Donkey Pumps and Disagreements.

The donkey pump, when used on the bilge, will be found to give quite as much trouble as the main bilge pumps, and will, like them, sometimes baffle for a time all the skill of an engineer. Its working parts, being, like those of the winches, light in proportion to speed of revolution, are more liable to general deterioration than the main bilge pumps. As a rule, also, its work is more varied and its connections more complex. Thus, when one part fails, all the parts have usually to be overhauled, sometimes causing delay and annoyance. When a donkey refuses to pump from the bilges, it may be the bucket that requires re-packing. Sometimes, also, a chip will get under the suction valve, and when its cover is removed drop back again into the pipe, and all appear in order. In such a case removal of the valve and flushing the pipe with water will work a temporary cure at least. Sometimes the valves stick up and drop back when their cover is removed. In such a case the valve has usually too much lift. Sometimes they stick down, as with the main bilge pumps. With a new valve in, it may be found that the guiding spindle is too long, and by bottoming on the pump prevents the valve from shutting. As previously noted with the main bilge pumps, experience is the only reliable teacher.

In illustration of a search for defects, the following is typical: The well in the tunnel began to fill, telling of a bilge pump not working. This was turned on the engine-room bilge, and acted as well as usual, showing that up to the branch pipe at least it was in order. The action of the pet valve was weak, and to intensify its effects the donkey pump was put on at a good speed, having been previously tried successfully on another bilge. Then the pipes were tracked, and tallow plastered over taps and joints, so that they at least might be made sure of, and so narrow the inquiry. In some cases it is necessary to remove and blank the plugs of the cocks to make sure of them; but in this case, by tracing the pipe with a light, a hole was found in the iron suction pipe in the tunnel at its front end, and here there was external corrosion from wet. Through this there was strong suction, but though this was stopped the pump still refused, telling of a choke in the pipe between the corroded part and the well, and also proving that the suction pipe up to that point was in perfect order. The pipe, being a wrought-iron one, nearly in one length, and also cemented to the top of the tank, was not easily uncoupled. About midway a hole was therefore cut in it, with a round-nosed chisel. As this showed no suction, it was plugged up with wood, and one hole after another was cut between the first one and the corroded part, and when at last one showed suction the choke was in the same way sought between it and the preceding hole, till the obstruction—a handful of waste dropped into the well by some careless engineer—was got at and removed, and that hole finally plugged up. The obstruction in this case had allowed a stronger suction than usual to come on the pipe, which gave way at the part weakened by corrosion. There is no tendency for such wooden plugs when inserted to work loose, as the suction is the only force acting on them, and keeps the plugs tight till another pipe can be got.

Besides being able to pump sea-water into the boilers when required, the donkey is also made to throw sea-water on deck for washing down purposes. It is so used every morning at sea, and thus brings the engineers into contact with the mates. The resulting relations between them are, unfortunately, not always of the most amicable kind, though a little yielding on both sides would entirely and easily prevent this. Both the engineering and deck departments frequently, however, stand too much on their dignity. Owing to the isolation of both from the rest of the world, trifles are apt to be regarded as essentials, and to cause mutual friction and irritation. In the daily washing down of the deck the object of the mate is to get as strong a jet of water as possible, that its force may wash away the dirt, and save the time of the sailors as well as their scrubbing brushes. The object of the engineer, on the other hand, is to run the donkey as slowly as possible, so as to save its wear and tear and consequent overhaulings; also to save steam pressure, which in many cases is of considerable importance; but his more especial aim is to prevent, as far as possible, the loss of fresh and hot water to the boiler, for these donkeys are seldom made to exhaust into the condenser. Such loss not only necessitates cold water being pumped in to take the place of the steam, but also makes more frequent blowing down necessary, to prevent salting up. There is thus a double loss of heat.

The result of such conflicting interests is, that the mates loudly complain that they can only get a feeble dribble of water, altogether inadequate to their needs, and this may also lead to complaints to the captain, who, if he is wise, will not interfere if he can help it. Subsequent retaliation may also widen the breach at a future time.

Owing to the variety of suctions and discharges on the donkey pump, an inexperienced engineer must be careful how he starts it for the first time. He must always see for himself that one cap at least is off the deck pipe, or the starting of the donkey may mean the starting of leaks at joints, and these are not so easily stopped as the other. He must also be sure that he is on the right suction, for surprising results have been known to follow the opening of the wrong tap, and the discharging of greasy bilge water on the deck, through the leathern hose in the hands of the boatswain, while the sailors were standing round expectantly with their scrubbers, and the mate presiding over all from the bridge. There is even a rumour of an unpopular passenger, who, while enjoying his usual morning bath by having the hose played upon him, was put to ignominious flight by the sudden change of the refreshing stream into dirty bilge water. This mystery was never cleared up. The hose, with full jet issuing, has sometimes been used with effect upon thronging Chinamen or Coolies, when other persuasion failed to get them off the deck. It is said that a hot stream drawn from the condenser heightens the effect, but this is not certain, as the donkey will refuse to pump with the water too hot, and few donkeys are made to draw from the condenser. A hose coupled to the boiler would serve the same purpose, but this would probably soon destroy the hose. Pulsometers, which are occasionally found in steamers, might perhaps give good results also.

Another phase of the skirmishing of departments is, that an engineer will refuse to start the donkey at a shout from a sailor or a whistle from a mate. He argues that, if worth having, it is worth asking for, and a convenient fit of deafness or the total invisibility of the engineer will sometimes produce the required civility when the expostulation has failed. Or, as politeness goes far, it is best when the inarticulate demand is for a stronger jet, to understand that it is for stopping it altogether, and to act accordingly. Such cross purposes will ultimately work wonders, after the bluster following it has subsided. However, in every case of complaint, it is best to go straight to the offender, state quietly your case, and the most unreasonable of men will thus often become the most considerate and courteous.

As illustrative of this strife: The engineer of a certain small steamer, being unwilling for his own reasons to make many demands on the stores on shore, went to sea short of iron buckets in the engine-room. As these are frequently required, his first proceeding was to mark several of the deck buckets with a private mark, and then boldly claim them, showing the mark as proof of ownership. The same method being subsequently applied by the mate to himself, he was again left short of buckets. This time he took the simpler method of stealing them bodily from the deck. As this he stoutly denied when taxed by the mate, who had received private information of their whereabouts, the latter proceeded to the engine-room on a tour of inspection. As this mate was the biggest man on board, and with the reputation of a hard hitter, the engineer did not resist the invasion by force. Failing elsewhere, the mate decided to go up the tunnel, and a lamp ready trimmed was handed to him. Having got half-way up the contracted space, the lamp showed unmistakable signs of going out. Close beside him was the shaft in unceasing revolution, and he knew that the catching of his clothes on the coupling bolts meant instant destruction. Then he who could keep a steady head on a reeling yardarm, now got giddy, and had to shout loudly for assistance and a light, both of which came to him after considerable delay. He was glad enough to get back on deck, and only knew long afterwards that the missing buckets were at the far end of the tunnel after all.

While engineers and mates thus disagree harmlessly, and chiefly to pass the time and add jest to the monotony, the chief engineer and the captain have often more serious disagreements. This usually begins over the supply of food, its quantity or quality, or want of variety. It is usually the captain's interest to spend as little on food as possible, especially when he contracts to provision the ship. This conflicts with the interests of the engineers, who, being jealous of their rights, do not always give due credit to a captain who tries to act fairly. Even a reasonable chief engineer cannot always ignore the complaints of his second, and must partly identify himself with them by laying them before the captain if the steward turns a deaf ear. In the confined spaces of a ship, any coolness between the captain and engineer rapidly develops, as a rule, into active hostility, which will remain and intensify all the time they are on the same vessel. This, though too frequent, is not universal, and in some steamers harmony prevails, as it should always do among the individuals composing the different departments.

(To be continued.)

A Powerful Hydraulic Tube Press.—A powerful hydraulic tube press for forming metal and steel tubes from circular plates by pressing or forcing them by the aid of mandrils through dies or annular rings has been constructed by Messrs. Bessemer and Co., for the Birmingham Small Arms Factory, for the manufacture of tubes of large size, and more particularly for making shrapnel, segment, and other hollow steel projectiles which Government are now anxious to obtain. Hitherto these projectiles used by the English artillery have always been made of either cast iron or steel; but the wrought material has proved so much so superior that forged hollow projectiles are bound to supersede the present cast metals. The press is built entirely of Bessemer steel, of sufficient strength to impart a downward pressure of 1,500 tons, with a stroke of 12ft. It is also furnished with two cylinders with an upward pressure of 500 tons for the purpose of stripping tubes from the mandrils. This novel process of producing hollow tubes and projectiles dispenses with the old method of boring them from a solid bar, which was not only very expensive, but greatly limited the output.

THE ELECTRIC MOTOR IN MINING OPERATIONS.—I.*

My plan in this paper is, first, to prove three general points, and then to take up the specific applications of the electric motor to mining work. The three points are:

1. The electric system is the simplest method known for transmitting and distributing any amount of energy from one locality to another, irrespective of the intervening distance.
2. The electric system with its applications is not in its infancy.
3. With the electric system small and large amounts of power can be transmitted economically and profitably short or great distances.

As a simple explanation of the production of electricity in large powers, and the way it is utilised in motors, I will briefly describe a simple form of dynamo and motor. Take a loop of wire, bend it into the shape of a rectangle, support it by its longest axis between the poles of an ordinary permanent horse-shoe magnet, with this axis at right angles to the general length of the magnet, and then rotate it. As the wire cuts through the magnetism emanating from the magnet's poles, electricity will be developed in the wire. If now you multiply these rectangles, winding them lengthwise upon an iron body, cylindrical in shape (the wires crossing at the ends, of course), arrange each rectangle so that its ends will come out off from the iron cylinder, connect them so that they will be as one wire, and solder the connected ends to a collector, whereby the electricity can be conducted away from the rotating part, and you have a modern first-class armature. This now rotate between the poles of a powerful electro-magnet instead of a permanent steel magnet, and, if you have planned large enough, you will obtain electricity equivalent to 1,100, or 1,000 H.P. What could be more simple? All dynamos are essentially the same, consisting of an armature or rotating part, and the field magnets or stationary part. Practically, nothing to wear out, or give out. A well-proportioned machine has an efficiency of over 90 per cent, and would out-last, twice over, the steam-engine driving it (if it be driven by this means). To produce electricity by dynamos, then, some ample driving power must be had. Steam, water, wind, and gas have all been used; but the first two only will be considered here.

An electric motor is a dynamo in every sense of the word; but instead of being driven it uses the electricity and drives; one produces, the other consumes.

Consider now the simplicity of an entire system. A dynamo, producing electricity and driven by steam or water; and two copper wires necessary for the complete metallic circuit, leading from the dynamo across the country, no matter what its nature, to the locality where the motors are located. This is all. Ordinarily, for convenience of application, motors are of a different shape from dynamos, but they could be identical.

The line-wire once put up, in a substantial manner, at a constructional cost of a few hundred dollars per mile, is up for all time, and requires practically no attention.

Compare such a line with piping or wire rope; compare dynamos and motors, with no more machinery about them than an emery wheel, with your steam or gas engine, your hydraulic or pneumatic motors—if there are any such—and what can the decision be but favorable to electricity?

I have been speaking of transmission; there are similar advantages in application. There is no such varied capacity in either steam, gas, air, water, or cable. Can we hoist, haul, transport, pump, ventilate, drill, blast, light, or heat, by any one of these? We can by electricity, and it is being done every day in the year. It is in this grand capability of subdivision, application, and distribution, for all purposes, that electricity reigns supreme.

Let me now see whether we have passed beyond the experimental stage or not.

Can you produce electricity enough to do heavy work? is a question often asked. In reply, I would say, that there are a score of electric light stations that are, every night, producing electricity equivalent to 1,000 H.P., and over, and distributing it all the way from 50ft. to 50 miles. Here, in Boston, there are about 3,000 arc lights, requiring fully 2,500 H.P. of steam engines. This enormous power is passing every night, in the form of electricity, through the wires which are stretched above the housetops all over the city.

There is no limit to its production or transmission. It is *possible* to transmit the total available power of Niagara Falls, some 7,000,000 H.P., to Boston. But, would it pay? is the question to solve. Taking all the electric lights throughout the country, and roughly figuring, we find that there is fully 250,000 H.P. engaged in producing electricity every night in the year. If there were an assured return for money advanced, this vast amount could be condensed into one station. According to the Tenth Census, thirteen of our western States and Territories, those producing most of our ores, excluding Pennsylvania, use only 211,840 H.P. in all their productions, mining or otherwise. Speaking of mining only, I think it safe to say, that for every H.P. used in mining there are ten employed in producing electricity. Financially there is fully $200,000,000 invested in the manufacture and use of electric apparatus for the mechanical production of electric currents for lighting and power. I bring forth these figures to illustrate that the use of electricity is not in its infancy.

A few words, now, as to what has been accomplished in transmitting power various distances. An arc light consumes about ·8 of a horse-power of electric energy; now there are almost innumerable circuits from 10 to 50 miles long throughout our country with arc lights indiscriminately placed their entire length. This is practically transmitting power; for a motor could be placed where any one of the lights is. Abroad, Marcel Deprez has transmitted 40 H.P. through 70 miles of wire, with a commercial efficiency of 56 per cent.

Mr. Brown, in Switzerland, has put into practical operation a plant transmitting 50 H.P. 5 miles, with a commercial efficiency of over 70 per cent. The Thomson-Houston dynamos are over 90 per cent efficiency, as are also their motors. Therefore, if a steam-engine dynamo and motor were placed side by side we would obtain of the 100 indicated H.P. of the engine over 81 H.P. in mechanical power from the motor.

To whatever distance we remove the motor from the dynamo we lose power in the circuit. Copper is the best conductor of electricity, and yet this offers resistance. To decrease this resistance, we have to increase the conductors in size. This point is similar to the general practical rules governing hydraulic transmission.

To illustrate in a comprehensive manner the cost of transmission, I have worked out several cases, and have tabulated them with numerous additional figures of interest:

Tables showing Cost of Complete Electric Plant for Transmission of Power Various Distances. Potential at Central Station, 560 Volts. Loss on Line, 10 Per Cent. Copper Wire, going and return.

Horse-power Transmitted.	1 Mile.				1 Mile.			
	Cost of Wire.	Cost of Line Construction.	Cost of Dynamos and Motors	Total Cost of Plant.	Cost of Wire.	Cost of Line Construction.	Cost of Dynamos and Motors	Total Cost Electric Plant.
1	25	175	250	450	500	1,000	250	1,750
5	100	175	875	1,150	2,500	1,000	875	4,375
10	200	200	1,750	2,150	5,000	1,100	1,750	7,850
25	500	200	4,350	5,050	12,500	1,100	4,350	17,950
50	1,000	250	8,750	10,000	25,000	1,300	8,750	35,050
100	2,000	250	17,500	19,750	50,000	1,300	17,500	68,800
500	10,000	300	62,500	72,800	250,000	1,600	62,500	314,100

Horse-Power Transmitted.	10 Miles.				25 Miles.			
	Cost of Wire.	Cost of Line.	Cost of Dynamos and Motors	Total Cost.	Cos of Wire.	Cost of Line.	Cost of Dynamos and Motors	Total Cost.
1	2,000	2,000	250	4,250	12,500	7,500	250	20,250
5	10,000	2,000	875	12,875	62,500	7,500	875	70,875
10	20,000	2,200	1,750	24,000	125,000	10,000	1,750	136,750
25	50,000	2,500	4,350	56,850	312,500	10,000	4,350	326,850
50	100,000	3,000	8,750	111,750	625.000	12,500	8,750	646,250
100	200,000	3,500	17,500	221,000	1,250,000	13,750	17.500	1,281,250
500	1,000,000	4,000	62,500	1,066,500	6,250,000	15,000	62,500	6,327,500

Horse-Power Transmitted.	50 Miles.				100 Miles.			
	Cost of Wire.	Cost of Line Construction.	Cost of Dynamos and Motors	Total Cost of Plant.	Cost of Wire.	Cost of Line.	Cost of Dynamos and Motors	Total Cost of Electric Plant.
1	50,000	15,000	250	65,250	200,000	30,000	350	230,250
5	250,000	15,000	875	265,875	1,000,000	30,000	875	1,030,875
10	500,000	20,000	1,750	521,750	2,000,000	40,000	1,750	2,041,750
25	1,250,000	20,000	4,350	1,274,350	5,000,000	40,000	4,350	5,044,350
50	2,500,000	25,000	8,750	2,533,750	10,000,090	50,000	8,750	10,058,750
100	5,000,000	27,500	17,500	5,045,000	20,000,000	55,000	17,500	20,072,500
500	25,000,000	30,000	62,500	25,092,500	40,000,000	60,000	62,500	40,122,500

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* Paper by G. W. Mansfield, read before the American Institute of Mining Engineers.

I have calculated these figures on the arbitrary potential of 560 volts, which is very low for the transmission of large powers; nevertheless, it was necessary to assume some basis. This potential is generally used to-day for power-circuits.

It will be noticed that the cost of copper is the principal item. To reduce this, I would state the following electrical fact :—

The cost of copper decreases as the square of the potential increases. Take, for instance, the extreme case in the last table, viz., 500 H.P. transmitted 100 miles. If we double our potential, making it 1,000 volts, the cost of our copper will decrease to one-quarter, or 10,000,000 dollars. If, now, we again double, we decrease to one-quarter again, or, at 2,000 volts potential the cost of copper would be 2,500,000 dollars. The total cost of the electric plant at this potential is 2,622,500 dollars. Obviously, there is a limit to the increase of potential; and in the transmission of such enormous powers, I would place that limit at one more doubling, or 4,000 volts. This is a possible voltage, for there are many electric-light circuits in our large cities to-day of this potential, and even higher.

1,000 volts. is a safe and easily handled potential; and if this potential were used, a large saving would evidently be effected. Professor Thomson has devised and patented a method whereby very high potentials can be used to overcome distance, and at the receiving station be reduced to lower safe-working potentials. This plainly means a tremendous saving in cost of copper.

Having briefly proved the three essential points started with, I will now take up, more specifically, the application of the electric motor to the various wants of the mining engineer.

For simplicity, I have divided the subject-matter into various headings, as follows :—

1. Drilling and excavating.
2. Hoisting.
3. Hauling.
4. Transporting.
5. Pumping.
6. Ventilating.
7. All other mechanical work (stamps, crushers, amalgamators, &c.).

1.—Drilling and Excavating.

Motors have already been used most successfully under this head, both drilling by impact and boring with diamond drills. The latter method was successfully used several years ago by M. Taverdon, in France, and in his experiments he was fully able to compete with steam or compressed air. Patents are being granted, and it is absolutely certain that this method will have an enormous development. In rapid tunnelling, in running adit levels, in deep and crooked workings, or in all work requiring hasty construction, the great trouble and expense of shifting and relaying pipes, with great losses due to leakage, &c., is avoided. The necessary wires simply cleated to wall or posts as work advances, thus always being entirely out of the way. In surface-work, the area over which we can work before changing steam-plant is vastly increased. In any direction, over rocks, hills, or gullies, on a straight line run the wires, for miles if desired, and drilling and boring can still go on. In excavating, the cranes, shovels, scrapers, &c., are all run with other motors, taking power from the same wires. These applications have already been made, hence it is needless to enlarge. One other point: the wires once in place, none but casual inspection is needed to keep them in order; whereas, with compressed air, steam, or hydraulic power, a set of men is required to be constantly on hand, repairing, changing, &c. Furthermore, the room which pipes &c., occupy in the shafts is by no means small, and is an important item to be considered as compared with wires.

In competition with electricity under this head there can be mentioned only two systems—compressed air and steam. Considering the former, its excessive first cost puts it out of the comparison, except in underground work. Here its redeeming feature is the introduction of fresh air. This is, no doubt, a valuable adjunct; but a mine ventilated by electricity, as it could be if electricity was used for drilling, &c., would not require compressed air for the benefit of the men.

It can be proven that the original cost of a compressed-air plant and its maintenance is much greater than that of the electric system, and that, for large work, it is not as economical to operate.

For short distances only, and in open work, steam may be more advantageously employed; beyond these conditions it cannot be considered a competitor.

2.—Hoisting.

With an abundance of water-power, located within a few miles of your mine, there is no reason why we cannot hoist entirely by transmitted electricity as economically as by steam. The variety of mines, and their natural surroundings, are so diversified, that it is difficult to give one or two illustrations to cover so much ground.

In all placer-mining, and mines of but a few hundred feet in depth, where there is uncertainty as to the location of workings, or the permanence of the location temporarily selected; in all preliminary explorations, &c., the electric motor is so easily moved and applied, and its scope so great, that it is vastly cheaper and better than any other means, beyond certain limits. In very deep and large mines, however, permanently located, probably steam, acting direct, is to be preferred.

The case, although not exactly similar, is analogous to the application of motors to elevators in our buildings. There are scores applied to this purpose, hoisting many tons in weight, and with speeds from 30 to 130 feet, and more, a minute; many of these have been in daily operation for from three to four years, always giving the highest satisfaction.

To be continued.

CORRESPONDENCE.

We do not hold ourselves responsible for the opinions of our Correspondents.

BOILER REGISTRY AND INSPECTION.

To the Editor of "The Practical Engineer."

Sir,—If the gentleman who wrote the letter on the above subject, which appeared in your issue of April 6th, would kindly forward his address to 7, Filbert Street, Leicester, he would greatly oblige yours, &c., Bright.

September 11th, 1888.

QUERIES AND REPLIES.

Timber Tests.—I should be glad if you could give a very simple, reliable, and easily applied available test as to whether timber, especially oak, ash, deals, and elm, are thoroughly seasoned and ready for use—that is, in planking and cut up in cases, where it cannot be ascertained how long it has been cut down and sawn, &c.—Inquirer.

Answer.—There are no available tests of the seasoning of timber except those of experience. A practical man judges by the appearance of the timber as to dampness, &c., and by the way it works under his tools. Timber that is cut up into boards and planks very soon gets seasoned by exposure of its surface to the air if kept in a dry place, and when thoroughly seasoned is usually warped, cracked, &c., and works dry under the plane, chisels, &c.—H.

Coal-mining.—Thanks to "H." for answer to my question; will he be so kind as to give me the reason why he would make the return the largest in all cases if a drawing road is not required?—A Deputy.

Answer.—In answer to your further query, the reason for making a return airway larger than the intake under the circumstances mentioned applies in every case, and is that the air on its passage through a mine gets heated (by the animal heat, lamps, heat of the strata, &c.), and consequently expands and occupies more space than it does when it enters the mine, and to keep the velocity and friction at as low a point as possible the size of the airways should be increased proportionally.—H.

Starting Gear.—A sketch and description of "Brown's steam and hydraulic starting gear" would be appreciated by S. B.

Answer.—In reply to "S. B's" query, I beg to say that Brown's steam and hydraulic starting gear is composed of a steam cylinder with valve. The piston rod prolonged has a bucket working in a hydraulic cylinder full of water or oil. The flow of the liquid from one end of its cylinder to the other is controlled by a valve attached to the prolonged valve spindle of the steam valve. The handle which opens and shuts the steam valve thus simultaneously opens and shuts the hydraulic valve. A crosshead between the two cylinders is connected by strong side links to the weigh shaft lever, which pulls over the drag links. By means of a system of floating levers, when the handle is put to any position the lever moves to a corresponding position, and then itself shuts off both valves, and stops there. The hydraulic cataract keeps the steam under such perfect control that a child can handle the largest engines. Further information could be obtained from Messrs. Brown Bros., Rosebank Ironworks, Edinburgh, who have issued an illustrated pamphlet with full particulars.—X.

Lift for Pump Clacks.—Will you oblige by giving the required lift for pump clacks or valves, and how to calculate the same in plain figures? Ex. 1.—For a 5in. ram pump, 2ft. 6in. stroke, running 30 revs. per min. Ex. 2.—For a 9½in ram pump, 1ft. 9in. stroke, running 26 revs. per min.—Engine Attendant.

Answer.—The principle of this question is the following: Suppose the valve raised to the required height; and also suppose a tin cylinder fitting exactly the rim of the valve and of precisely the same height as the lift of the valve, then the area of this cylinder is equal to the area of the valve.

If d = diameter of valve,
h = lift of valve,
Then area of cylinder $= d \times 3{\cdot}1416 \times h$,
And area of valve $= d^2 \times {\cdot}7854$,
Therefore— $d \times 3{\cdot}1416 \times h = d^2 \times {\cdot}7854$

$$\text{and } h = \frac{d^2 \times {\cdot}7854}{d \times 3{\cdot}1416} = \frac{d}{4.}$$

Hence the rule: Make the lift of the valve equal to one-fourth the diameter. There is nothing to be gained by increasing the lift beyond this. In a pump the diameter of the ram or piston and the velocity with which it moves determines the area through the valves. The area of the valves being fixed, the diameter and lift are, to some extent, matters of opinion. The larger we make the diameter of the valve the less will the lift require to be, and this is very desirable especially in quick-speed pumps. It is a common practice now to make the area through the valves equal to the area of the pump ram.—Draughtsman.

Tempering Steel Tools.—Can any reader tell me what is the best method for tempering steel springs and cutting tools?—Electron.

Answer.—Coiled springs of steel wire are tempered by heating them in a box, or piece of gaspipe, in which they are packed with bone dust or animal charcoal, precisely as though they were to be heated for case-hardening. If a piece of gaspipe is used, which is very handy in such work, one end should be closed by a screw-plug or cap, and the open end luted with clay. When the box or pipe is sufficiently heated, say to a deep red, remove the spring or plunge the receptacle and its contents together into a bath of animal oil. Do not attempt water-hardening or the use of crude petroleum. If common whale oil is not handy, melt lard, and use it while it is liquid. The wire will be sufficiently hard to require "drawing." This should be done by putting the spring in a shallow pan, with tallow or animal oil, over the forge fire, and agitating the pan and its contents until the oil takes fire. Take the springs out, and when the oil is burned off cool them in water.

To Temper Tools.—A word as to the quality of the steel. This should be uniform throughout, and it is always better to have the tools rather too hard than too soft, for use tends somewhat to diminish the temper. The best method is to melt a sufficient quantity of lead to immerse the cutting part of the tool in. Having previously brightened its surface, plunge it into the melted lead for a few minutes, till it gets sufficiently hot to melt a candle rubbed on its surface; then plunge it in again, and keep it there till the steel assumes a straw colour, but be careful not to let it turn blue. When that is the case, take it out, rub it again with the tallow, and let it cool. If it should be too soft, wipe the grease off, repeat the process without the tallow, and when it is sufficiently hot plunge it into cold spring water, or water and vinegar mixed. By proper attention to these directions, and a little practice, every workman will have it in his power to give a proper temper to the tools he may use. If a saw is too hard, it may be tempered by the same means. But here observe that the temper necessary is different to the other cutting tools; you must wait till the steel just begins to turn blue, which is a temper that will give it more elasticity, and at the same time sufficient hardness. Mercury is a specially good liquid for tempering steel cutting tools, and good steel when forged into shape and tempered in a bath of mercury will cut almost anything. I have seen articles made from ordinary steel, which have been hardened and tempered to a deep straw colour, turned and cut with comparative ease by tools from good steel tempered in mercury.—Draughtsman.

Non-Freezing Liquid for Indicator.—I have an indicator in which water is used to indicate the pressure, but as it is exposed to the weather the water freezes in winter. Will some of your readers kindly inform me whether something could be mixed with the water to prevent it from freezing; or of any other liquid susceptible to slight differences of pressure, and which will not freeze or corrode iron or brass?—Trianole.

Answer.—If a little glycerine be mixed with the water, it will probably accomplish the object, or, better still, if the water be replaced entirely by glycerine. If the glycerine be objectionable for any reason, you may use spirits of wine (alcohol). The freezing point of both these fluids is much lower than any temperature likely to occur in this country, and neither of these, so far as we are aware, has any injurious effect either upon brass or iron.—Ed.

Cement for Brass.—Will you or some of your numerous readers kindly give me a recipe for or the name of the best manufactured cement for brass? I want to attach brass rings to the outside of a brass cylinder by means of cement.—Marine.

Answer.—A soluble cement that will fasten brass to brass I never heard of. Soldering, or, more correctly, brazing, is the best means that "Marine" can adopt. If the work is on a small scale, and the metal soft, a copper soldering iron may be used. In many cases, however, the work may be done more neatly without the soldering iron, by filing or turning the joints so that they fit closely, moistening them with the soldering fluid (composed of spirit of salt, with zinc and a little salammoniac), placing a piece of smooth tinfoil between them, tying them together with binding wire, and heating the whole in a lamp or fire till the tinfoil melts. Pieces of brass neatly joined this way scarcely show the joints. For large work a Bunsen gasburner, or a coke fire with forced draught, may be used. Soft solders do not make malleable joints. To join brass of high melting point, so as to have the joint very strong and malleable, hard solder must be used. For this purpose equal parts of silver and brass are excellent, though for very infusible brass nothing is better than a silver coin rolled out thin, which may be done by any silversmith or dentist. This makes decidedly the toughest of all joints, and as a little silver goes a long way it is not very expensive. For hard solders borax is the best flux. It dissolves any oxides which may exist on the surface of the metal, and protects the latter from the further action of the air, so that the solder is enabled to come into contact with the surfaces which are to be joined. Hard solders are usually reduced to powder either by granulation or by filing, and then spread along the joints after being mixed with borax which has been fused and powdered. It is not necessary that the grains of solder should be placed between the pieces to be joined, as with the aid of the borax they will "sweat" into the joint as soon as fusion takes place. One of the essential requisites of success, however, is that the surfaces be clean, bright, and free from all rust. The solder known as "soft spelter," for brass work, is simply composed of equal parts of copper and zinc.—Draughtsman.

Book on Railway Switches and Crossings.—Can any reader of your practical and valuable paper inform me of the most modern edition on railway switches and crossings, with name of author, and cost?—W. L.

Artificer in the Navy.—Can any of your numerous readers afford me any information as to the steps required to become an artificer in the navy? Is it requisite to pass an examination? and is it necessary to enlist for any length of time? What is the rate of pay? If an examination has to be passed, what books is it desirable to study?—W. H. A.

Helical Wheels.—Can any of my fellow-readers inform me of the best mode of setting out the teeth of a pair of bevel helical wheels, the larger wheel to be 34·8in. diameter, with 6in. face and 73 teeth, 1½in. pitch, and the smaller one or pinion 18·14in. diameter, with 6in. face and 38 teeth 1½in. pitch? Also a plain spur wheel 77·98in. diameter, with 140 teeth, 1¾in. pitch, to work in a pinion 40·1in. diameter, with 72 teeth. Any information with regard to making the patterns would oblige.—J. W. J.

Navy Electrician.—Could you or any of your numerous readers give me any information as to the requirements of electricians in the Navy, and how one who has a good knowledge, both practical and theoretical, of electric lighting may become one?—T. H.

Flat Cast-iron Surfaces (Ribbed).—Any reliable data for calculating the bursting pressure of a flat cast-iron ribbed surface, such as a steam chest cover, or casing side, will be thankfully received by Orion.

Deck Cage for Mine.—A sketch and description of a deck cage and supports for mining purposes would be much appreciated by Junior Draughtsman.

Designing Winch Barrels.—Can any reader give me a formula for finding the breaking and also safe working strain for the barrel of a winch, first, when the barrel is a plain cylinder, and, secondly, when it is bellied inwards so as to have a less diameter at the middle than at the ends? Which will be the weakest point when a load is being lifted? I should be glad also to be shown—by diagram or otherwise—the strains which come upon the bearings.—Nimrod.

Hardening Steel.—Can any reader inform me if there is any book published on the hardening and tempering of steel, explaining the why and the wherefore? If so, what is the price, and by whom is it published?—Coot.

Pitch of Propeller.—Will "Omicron" please assist me in the following: How can I find the pitch of a detachable propeller blade before it is fixed on the propeller boss, supposing the blade to be of uniform pitch?—E. B., Swansea.

To Draw a Straight Line.—I am obliged to "Omicron" for his kind reply to my query *re* valve diagrams, in your issue of September 7th, and offer an apology for my omissions of the data mentioned. If not imposing too much on his good nature, may I invite his solution of the following query, taken from the Science and Art Examination Paper in *Steam* in 1886, viz.: "Arrange the dimensions of an instrument for giving a straight line path of 12 inches."—C. J.

Pressure on Spiral Springs.—In the answer which I gave "G. B." on the above, and which appeared on page 435, the last line but one from the bottom of the first column should read, "the modulus E required to be $\frac{16,000 \times 100}{125} = 12,800$ tons," &c.; this follows from the deflection in the case cited being 25 per cent in excess of that found when E was taken at 16,000 tons.—Orion.

TO CORRESPONDENTS.

Felix.—We have received your query *re* lift of pump clacks, but you are a little wrong in your reasoning; you give the lift for a 6in. valve with an 8in. pipe as 2¾in., whereas the maximum lift for a valve should not exceed one-fourth the diameter in any case. See the further answer to this query in this week's issue.

M. D.—"Hydraulics" is a word with a very wide meaning, and we feel some difficulty in advising you. Messrs. E. and F. Spon, 125, Strand, London, publish some books on the subject, and your best course would perhaps be to write that firm for a catalogue, and select for yourself that work which best meets your wants.

H. F. Boughton.—We have received your communication of the 11th inst., but we are compelled, on account of press of space, to restrict our correspondence column to the discussion of matters which have either already appeared or have some practical bearing. The subject you discuss, although highly interesting, would, we fear, be rather too speculative for most of our readers.

Student.—We believe the book was published by Mr. McNaught himself, but we understand it is now out of print.

Coot.—You can hardly patent a *method* of performing an operation, but if the operation of hardening you refer to depends upon the use of some special mixture, you could sell the mixture under some distinctive name, and, by registering the name, protect your interests in that way.

Airdrieonian.—Your question is a very simple one, and involves nothing beyond a little elementary geometry, too elementary indeed to justify us in occupying our space with the diagrams which would be necessary to show the actual working of the question. If you are at work in a boiler-shop, there is surely some workmate able to explain such a simple question; but if not, write us again, and we will try and send you an explanation by letter.

MISCELLANEA.

Bequests by the Whitworth Legatees.—The legatees of the late Sir Joseph Whitworth have just announced a further series of gifts to charitable and educational institutions, amounting in the aggregate to 25,000 guineas.

Preserving Telegraph Poles.—Telegraph poles are preserved in Norway by making an augur hole about 2ft. from the ground, in which 4oz. or 5oz. of sulphate of copper in coarse crystals are placed, and plugged in. The chemical is gradually absorbed by the wood, until its whole outer surface turns a greenish hue. The sulphate requires an occasional renewal, and is said to be a perfect preservative.

Shipping Trade on the Clyde.—During August nineteen vessels, with an aggregate tonnage of 28,109, were launched from the Clyde shipyards, as compared with nineteen of 35,575 tons in August, 1887. For the eight months of the present year now expired the total tonnage placed in the water has been 146,461, as against 131,641 in the corresponding period of last year. It is estimated that in the course of the month the new orders booked will amount to at least 36,000 tons.

Melinite.—This new explosive has recently been the subject of a series of interesting experimental operations at Lydd Camp, under Captain Hamilton, R.E., and the results are stated to have been highly satisfactory. The explosive does not supersede gunpowder as a motive power, but is used in shells, the concussion caused by the missile striking an object releasing certain liquids, and their contact with the melinite causing it to explode with disastrous effect. One great advantage is that the substance is non-explosive when ignited by fire.

Height of Meteorological Stations.—Europe cannot compete with the United States in the loftiness of its stations for taking meteorological observations. There are only two stations on the European continent which reach any very great height, being about 10,000ft. and 11,000ft. respectively. Among the stations in America is Pike's Peak, which has an altitude of 14,100ft.—or only about 1,600ft. lower than the summit of Mont Blanc—and exceeding by more than 3,000ft. any meteorological station in Europe. These great heights are much more accessible in the United States than in Europe, there being five stations in America where a height of 11,000ft. or more is reached by railroads built for facilitating mining work. The highest of those in North America is Mount Lincoln, in Colorado, the mining works on which are 14,297ft. above the sea level, and it has a meteorological station conducted by Harvard College. Another station is placed part way up the mountain, at a height of 13,500ft. In the Andes range, in Peru, continuous meteorological observations are also carried on, the loftiest point for this purpose being 14,300ft. above the level of the sea.

An Electric Dogcart.—A private trial was made in London a few days ago of an electric dogcart which has been constructed by Messrs. Immisch and Co., of Kentish Town, to the order of the Sultan of Turkey. The vehicle presents the appearance of an ordinary four-wheeled dogcart without shafts, and has seats for four persons. Beneath the seats are placed the accumulators which supply the electricity to the motor. The accumulators, 24 in number, are of special type, and contain a charge sufficient to propel the vehicle for five hours at an average speed of ten miles per hour over an ordinary track. Their weight is about 7 cwt., and that of the carriage, all complete, a little over 11 cwt. The motor is one of Messrs. Immisch's one H.P. type, and in this case uses a current of 20 ampères, with an electro-motive force of 48 volts. The connection between the motor and the carriage is effected by a chain running round the off hind wheel, the revolution of the motor to those of the wheel being as 18 to 1. When the vehicle is running at a speed of ten miles per hour the motor makes 1,440 revolutions per minute and develops a three-quarter H.P. The steering is effected by means of an adaptation in the fore-carriage. A shaft, surmounted by a steering handle, passes through the footboard and terminates in a pinion which works in a toothed rack fixed above the fore axletree. The driver thus possesses perfect control over the direction of the vehicle, and can regulate the speed by means of a foot-brake acting on both hind wheels.

A New Gas.—A new gas, possessing some curious properties, has been discovered by Prof. Thorpe and Mr. J. W. Rodger, in the research laboratory of the Normal School of Science. It is a sulpho-fluoride of phosphorus of the composition PSF_3, and is termed by its discoverers thiophosphoryl fluoride. The best method for its preparation consists in heating pentasulphide of phosphorus with lead fluoride in a leaden tube. It may also be obtained by substituting bismuth fluoride for the fluoride of lead, the only difference between the two reactions being that the second requires a higher temperature than the first. Again, when sulphur, phosphorus, and lead fluoride are gently warmed together, an extremely violent reaction occurs, but if a large excess of the fluoride of lead be employed a tolerably steady evolution of the new gas occurs, the excess of the lead salt appearing to act as moderator. It is spontaneously inflammable. If collected over mercury, upon which it exerts no action, in a tube terminating above in a jet and stopcock, and the latter be slowly turned so as to permit of its gradual escape, the gas immediately ignites as it comes in contact with the air, burning with a greenish-yellow flame tipped at the apex with blue. If, however, a wide tube containing the gas standing over mercury be suddenly withdrawn from the mercury trough, the larger mass of gas ignites with production of a fine blue flash, the yellowish-green tint again being observed as the light dies away.

An Artesian Well.—Messrs. C. Isler and Co. have just completed a 436ft. artesian bored tube well at Messrs. Hargreaves and Co.'s brewery, Abridge. The chalk was reached 80ft. nearer the surface than anticipated by several gentlemen connected with the geological survey. The following strata were passed through before the chalk was reached: Blue clay, 227ft.; hard sandy ditto, 9ft.; sandy clay and pebbles, 8ft.; mixed coloured sand, clay, shells, and pebbles, 20ft.; green sand, 12ft.; dark green sand and pebbles, 50ft.; chalk, 110ft.; total, 436ft. The water stands at 37ft. from the surface, and the supply obtained is over 1,500 gallons per hour. These results are particularly gratifying, as at Epping, Longton, and other places where wells have been sunk on the old principle to over 1,000ft. deep, they have totally failed. The supply was reached in the first 100ft. in the chalk, and it was by employing a specially-designed deep-well pump, and working it at various depths, that the above satisfactory results were obtained. Some months ago similar results were obtained by the same firm at Pyrgo Park, Havering, for Mr. W. E. Gibb, after reaching the depth of 666ft. from the surface. The water supplied from these deep-seated springs is of well-known purity, and fit both for domestic and brewing purposes. The means taken are so effectual that there is no possibility of any percolation from the surface, or from any of the objectionable springs passed through.

SELECTED PATENTS.

APPLICATIONS FOR LETTERS PATENT.

September 7th.

12920 Paper-covered Metal Tubes, C. Batson, Birmingham.
12922 Drag for Looms, J. K. Caird and J. Stewart, Glasgow.
12929 Coupling, R. Hill, Heywood.
12933 Rotary Pumps, R. M. Simpson, Melbourne.—[Complete Specification.]
12934 Apparatus for Heating Water, W. J. Payne and A. J. W. Johnson, London.
12939 Furnaces or Flues, T. W. Duffy and W. J. Cousins, London.
12948 Petroleum Hot Air Engine, C. Wells, Middlesex.
12951 Dies, D. E. Kempster, London.—[Complete Specification.] [Date applied for, under Section 103 of the Patent, &c. Act, 1883, 8th Feb., 1888.]
12952 Manufacture of Articles in Metal, D. E. Kempster, London.—[Complete Specification.] [Date applied for, under Section 103 of the Patent, &c. Act, 1883, 29th Feb., 1888.]
12956 Hand Holes, T. Mudd, Liverpool.
12960 Automatic Oilers, J. T. Smith and D. Henderson, London.—[Complete Specification.]
12961 Driving Gear, O. Schimmel, London.—[Complete Specification.]
12965 Railway Axle Boxes, O. Imray, London. (G. T. Evans and J. Goff, New South Wales.)

September 8th.

12971 Pulleys, &c., G. Smith and E. Smith, Thrapston.
12975 Automatic High-pressure Water Filter, W. McKenzie, London.
12978 Securing of Nuts, Bolts, and Bolt Heads, W. Bycrs, Gateshead-on Tyne.
12980 Hydraulic Jacks, G. C. Marks, D. T. Young, and H. W. Young, Birmingham.
12982 Apparatus for Obviating Pin-holes Rollers, C. F. Cockshott and J. E. Jowett, of the firm of Cockshott and Jowett, Bradford.
12988 Thermo Automotor, F. G. A. Horstmann, Bath.
13006 Valves, J. H. Braidwood, Liverpool.
13026 Heaters, F. Farquhar, M. J. Farquhar, and H. B. Farquhar, London.

September 10th.

13039 Steam Generators, G. Rose, Glasgow.
13050 Generating Illuminating Gas and Gaseous Fuel, O. Langberg, London.
13052 Hydraulic Cranes and Lifts, J. H. Shaw, W.C.
13057 Gas-holder Guiding Apparatus, G. T. Livesey, Westminster.
13071 Grinding and Polishing, T. Hunt, London.
13072 Metallic Alloys, B. Willcox, London. (La Société le Ferro-Nickel, France.)
13074 Purification of Gas, W. Kusnezoff, London.
13075 Speed Indicator, F. Jacob, London.

September 11th.

13090 Packings, H. G. Small, Manchester.
13095 Pullies, T. Gare, Stockport.
13098 Steam-regulating Valve, W. Allen, Manchester.
13107 Fur-cutting Machinery, H. Durselen, Manchester.
13111 Malleable Pipes, G. H. Lloyd, Sutton Coldfield.
13120 Adjustable Cranks, G. H. T. Beamish, London.
13122 Armatures of Dynamo-electric Machines, E. J. Paterson and C. F. Cooper, Dalston.—[Complete Specification.]
13127 Metallic Strap Fasteners, E. Latham and E. A. Sawyers, London,—[Complete Specification.]
13130 Balanced Gearing, C. H. Tuckwood and W. Tuckwood, London.—[Complete Specification.]
13131 Water Heaters, A. J. Boult, Middlesex. (E. Gurney, Canada.)—[Complete Specification.]
13136 Tapers on Metals, A. J. Boult, Middlesex. (J. B. Armstrong, Canada.)—[Complete Specification.]
13137 Interchangeable Coupling, E. Nunan, London.
13141 Heating Feed Water, C. E. Hudscn, London.—[Complete Specification.]
13143 Drawing Rollers, G. Paley, London.
13145 Incandescent Electric Lamps, E. Böhm, London.

September 12th.

13159 Fireless Metallic Alloys, W. J. Morgan. Birmingham.
13161 Wedgeless Railway Chair, H. Mould, Eastbourne.
13168 Temples, G. Spencer, Bradford.
13173 Pentagraph Tracing or Engraving Machines, J. Bryce and A. Knox, Glasgow.
13181 Gas Regulators, R. R. Beard, Bermondsey.
13185 Cisterns, &c., J. King, Reading.
13186 Valve, A. McGlashan, Glasgow.
13190 Automatic Stopping Devices, G. Josephy, London.
13199 Valves of Taps, J. Hopwood, London.
13200 Guards, S. H. Sturtevant, Sheffield.
13206 Caloric Engine, C. Wells, Middlesex.
13215 Electrical Batteries, W. Clark, London. (L. Maiche, France.)
13221 Mechanical Telephones, G. F. Redfern, Middlesex. (G. F. Shaver, United States.)

September 13th.

13231 Pumps, L. Roovers, Liverpool.
13234 Extracting Tin, L. A. Groth, London. (O. Leprevost-Bourgcrcl and E. Pierron, France.)—[Complete Specification.]
13235 Gas Engines, J. A. Wanklyn and W. A. Byrom, London.
13236 Sectional Warping Machines, J. F. Kirk and F. Reynolds, London.
13237 Bolting or Riveting, W. Murray Glasgow.
13238 Mechanical Stokers, A. Thomson, Glasgow.—[Complete Specification.]
13240 Supplying Water to Locomotive Engines, G. H. Cawthorn, Halifax.
13242 Motive Power, G. S. Simister, Manchester.
13245 Machines for Breaking Hard Substances, J. G. Richmond, of the firm of Richmond and Chandler, Manchester.
13247 Differential Motion, J. Heap, Manchester.
13249 Pickers, A. Percival, Rochdale.
13253 Cleaning Hackle Pins, J. Gordon, Antrim.
13255 Steam Generators, T. Lishman, London.
13263 Pressure Pumps, O. Imray, London. (W. Lorenz, Germany.)
13265 Indicator, T. Northey, London.—[Complete Specification.]
13270 Hot-rolling Machines, H. S. Statham and A. O. Chudleigh, London.

PUBLISHERS' ANNOUNCEMENTS.

BACK NUMBERS of "The Practical Engineer," from the commencement, can be obtained at either of our offices in London or Manchester, or by order of any Newsagent.

Vol. I. (bound), containing Nos. 1 to 44 inclusive, from March to December, 1887, price 6s. 6d., can still be obtained by order from any Newsagent, or will be forwarded, carriage paid, from either of our offices on receipt of the amount by postal order or stamps.

Numerous complaints having been made to us by Subscribers of the difficulty they experience in obtaining copies of the *Practical Engineer* in certain districts, we have to state that the Journal can be obtained by any Newsagent through the ordinary trade channels, and no difficulty should therefore exist in obtaining copies by order of any Newsagent.

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EDITORIAL NOTICES.

All communications for the Editor of this Journal should be addressed to 6, Victoria Station Approach, Manchester.

Communications intended for insertion in the current week's issue should reach us not later than Tuesday Evening.

We cannot undertake to return rejected manuscripts or drawings unless accompanied by a stamped and directed envelope.

Contributors are requested to write on one side only of the paper. Sketches should be sent on separate sheets.

TO ADVERTISERS.

Advertisements intended for insertion in the current issue should reach us on Wednesday morning at the latest.

THE
PRACTICAL ENGINEER.
SEPTEMBER 28TH, 1888.

EXPANSION OF IRON BRIDGES.

From time to time attention is freshly drawn to allowances for expansion and contraction of ironwork due to changes of temperature, and it appears to us that in this matter one point has been entirely overlooked in almost every large bridge that has been constructed, and equally ignored in the small ones, and that is, lateral expansion. The reason of this neglect may soon be found; the width of the bridge usually being much less than its span, its corresponding expansion and contraction is therefore correspondingly *small in extent*, and therefore has been thought in most cases sufficiently unimportant to be safely neglected.

In considering merely the extent of the expansion, another most important result of variations of temperature is left out of the calculation, and that is the amount of *stress* corresponding to such expansion, for it is obvious that if the expansion under a rising temperature, or the contraction under a falling one, be resisted, stresses in the material must ensue. The extension caused in wrought iron by a stress of one ton to the sectional square inch is equal to the expansion due to 13½ degrees Fahr., and the expansion due to the whole variation of temperature in England is equivalent to the extension accruing from a tension of six tons per sectional square inch.

The actual amplitude of the extension or expansion, as the case may be, is proportional to the length of the body acted upon by strain or heat, so it will be seen that the amount of stress caused by expansion unprovided for will not depend upon the absolute amount of such expansion, but upon the temperature producing it; hence, if we suppose a bridge to be constructed without any allowance being made for expansion, there will be the same force per sectional square inch acting laterally as there is longitudinally, although the actual measured increase is less in proportion as the width is less than the length of the bridge.

As a matter of fact, the gross pressure at the bed-plates will not be so great laterally as longitudinally, because there are not so many square inches of section in the cross as in the main girders, except in cases where heavy end transverse girders are used; but if lateral expansion is not provided for at the bearings, additional stresses will be brought upon the main girders in the following manner.

The cross girders throughout the bridge will tend to expand equally, and if the main girders are laterally restricted at their ends, the effect of this movement of the cross girders must be to bend them laterally, the maximum strains being opposite the ends of the cross girders nearest to the points of support, for there the expansion will be most strongly resisted, the lateral distortion of the main girder becoming easier as the centre of the span is approached; in point of fact, the lateral strain thus brought upon the main girder flange will be analogous to that produced by a varying load upon a girder fixed at both ends. The horizontal stresses due to these lateral pressures will also alter the resultant stresses in the flanges of the main girders, the direction in which the resultants are varied depending upon the season of the year in which the erection of the bridge is completed. The effect of the lateral forces upon the main girder flanges will be to increase the longitudinal strains on one side and diminish them on the other, and this extra must be allowed for in determining the sections of the main girders. Where the cross girders are carried on the top flanges, the girders being carried on their bottom flanges, this strain will not occur, as the cross bracing expanding will press the top flanges apart, they not being restrained by the masonry of the piers; in this case, the strains will fall upon the end standards and the bottom horizontal bracing, the section of which is not sufficient to allow of its expansion seriously affecting the bottom flanges of the main girders.

It is of no use to point out these mal-arrangements without indicating the remedy; but first let us consider what the common practice has been up to the present time. For bridges of small span, flat sliding plates at one end of the structure have been considered sufficient, the travel not being great, but where longer spans are used the movable ends of the girders have been placed on rollers moving in the direct line of such girders, the other ends being taken upon plane plates. Under these circumstances, if room were left, lateral expansion would take place, causing sliding of the bearing plates, in one case upon the lower bed-plates, and in the other upon the rollers in the direction of their length. The longitudinal expansion needs only to be allowed for at one end of the bridge, but the lateral expansion should be provided for at both ends.

Taking a general view of the whole case, it is obvious that the structure, being made of the same material throughout, will expand symmetrically, and therefore, if it is supported at each corner, the expansion at the points of support will take place in the direction of diagonal lines drawn from corner to corner of the bridge, and therefore in such directions should the centre lines of the bed-plates lie.

We have seen that where *plain* bearing plates are used, or *plain* rollers, the lateral expansion, though not especially provided for, is not absolutely prevented, and may therefore be assumed to take place with the same regularity as the longitudinal expansion; but of late years a mode of construction has been much used which absolutely precludes lateral expansion.

It having been thought possible that lateral movement of the whole bridge upon its bearings might be caused by wind pressure, several engineers have thought it necessary to guard against such an occurrence by grooving the expansion rollers, or plates, as the case might be, these grooves being arranged to work on fillets; or in other designs, the rollers have been made with collars to work in grooves on the bed-plates. But with either design, the girder ends are laterally locked and expansion resisted, and besides this, the roller fillets being by the lateral pressure jammed against the sides of the grooves, the longitudinal expansion of the girder will also be materially resisted, all this tending to the distortion of the work and to the setting up of extra, abnormal, and unnecessary strains in the structure.

As to the means for allowing of expansion and contraction, the choice generally lies between sliding plates and rollers. In some isolated cases suspension links at one end of the span have been used, and no fault has been found with them, one bridge fitted with them having now stood for upwards of forty years, but they must be more calculated to favour vibration than the commoner forms of support. In the comparison of sliding plates with rollers, many arguments unfavourable to the use of the latter occur. It is easier to obtain an evenly flat surface than to turn a number of rollers to exactly the same diameter, and if the rollers vary in diameter they do not share equally in the load, and therefore it is not properly distributed upon the bed-plates. Again, rollers afford only very narrow bearing surfaces, which must render the superstructure less steady than when the bearing is continuous, and so increase the tendency to vibration. The conclusion, therefore, appears to be in favour of sliding plates, provided they can be kept properly lubricated, and their rubbing faces maintained without deterioration. There is no difficulty about the lubrication, and materials that will resist oxidation can be chosen for the rubbing surfaces.

THE HYDE JUNCTION RAILWAY ACCIDENT.

A REPORT has just been issued by Major-General Hutchinson on the accident which occurred on the 14th of July last, at Hyde Junction, near Manchester, on the main line of the M. S. and L. Railway, and by which four persons were killed on the spot and 14 others injured. The disaster, it will be remembered, arose from the fracture of the leading axle of a four-wheeled third-class railway carriage, which caused the carriage to leave the rails and collide with the tender of a goods train travelling in the opposite direction. In an article which appeared in our issue of August 3rd, dealing with the coroner's inquiry, we pointed out that it appeared pretty plain, from the evidence, that if the train had been fitted with suitable means of communication between the passengers and those in charge, the collision, in all probability, would have been averted. This opinion the Board of Trade report fully endorses. With regard to the cause of the failure of the axle the report affords no information beyond that which was tendered at the coroner's inquest, and which has already been presented to our readers. Major-General Hutchinson considers it impossible to discover why the axle should have broken when it did, but thinks that if the engine had been fitted with automatic brakes the train would have been pulled up in time, and points out, in conclusion, that had the carriage been six-wheeled instead of four-wheeled the fracture of the axle would not, in all probability, have been followed by the tilting and the subsequent collision.

MANCHESTER ASSOCIATION OF ENGINEERS AND TECHNICAL EDUCATION.

AMIDST the many vague cries and spasmodic efforts of well-meaning but misguided philanthropists on behalf of technical education, it is pleasant to record a modest but substantial service that has just been performed by the Manchester Association of Engineers, in the shape of a small pamphlet which the association has published, giving the courses of study recommended for evening class work to those who are engaged in the workshop during the day.

The question, "What subjects ought I to study?" is one that is frequently asked by apprentices of their elders, and one which cannot always be answered off-hand, as the reply depends in great measure on the special line of engineering the inquirer intends to follow, and the extent of his knowledge at the time. A subject which may be of primary importance in one section of engineering may only be of secondary importance in another.

The pamphlet before us indicates to the youths engaged in the workshops in the various branches of engineering which are the more important subjects, and which may, with advantage, be studied first. The course of reading indicated is intended to enable youths to become efficient workmen, and prepare them, when their practical experience is mature, for holding good positions in workshops, where all classes of engines, boilers, bridges, cranes, machine tools, cotton and textile machinery, electrical, gas, and hydraulic appliances, are constructed. To meet the wants of these different classes, and to enable the student to test his progress from time to time by a graduated course of examinations, the syllabus of subjects indicated is based upon that of the Science and Art Department, and the classes in connection therewith are now found in nearly every town, and are thus easy of access to all students.

Another reason why these classes are selected is, that upon the results of the Science and Art Examinations the Whitworth and National Scholarships are awarded, so that should a youth, after a few years' steady work, find himself able to compete for one of these, his studies will prove directly available to him.

The syllabus is arranged in the form of a convenient table, showing at a glance which subjects should be taken by the various classes of students. The first column points out those which are essential to all grades; the second those which are highly desirable for every youth; while the following columns indicate those which are suitable for the various sub-divisions of the profession already indicated. Appended to the table are a series of valuable notes dealing with the various subjects, pointing out their practical bearings and indicating the text books which it will be found most convenient to study. Following these are a series of notes dealing with the various trades which will be found of advantage not only by apprentices, but also by parents and guardians, as affording a general idea of the scope, as well as of the special ability required for the various trades. Those notes have evidently been drawn up by various members of the association possessing special and exceptional knowledge in some particular branch. The work altogether has evidently been a labour of love, and forms a most valuable contribution to the literature of this subject, for which the Manchester Association of Engineers deserves the thanks of the entire profession. In order to enable the pamphlet to be disseminated as widely as possible, it has been issued at the mere nominal price of twopence, and we would strongly advise every youth, no matter what engineering trade he may be engaged in, to get one. Copies may be obtained from F. Walthew, Esq., the secretary to the association, 31, Shrewsbury Street, Old Trafford, Manchester.

BOILER EXPLOSIONS.

Recent Board of Trade Reports.

Since our last reference to these reports, a number of additional ones have been issued. The casualties with which many of them deal are of a very trivial character, and hardly justify, in our opinion, the expense of issuing an official report. In order, however, that our reference may be continuous, and that our readers may be in possession of a complete record of these casualties, we will take up the reports seriatim, from the point where our last notice ceased.

Vertical Boilers.—Weakness of Fireboxes.

Report No. 269 refers to the explosion of a small vertical boiler, which occurred at Holbeach, in Lincolnshire, on the 25th of April last, and arose from the collapse of the internal firebox, a method of failure, by the way, to which these small vertical boilers appear to be particularly prone. The boiler in question was rather diminutive, measuring about 4ft. in height by 3ft. in diameter in the shell, and about 2ft. in height by 2ft. 6in. in diameter in the firebox, which was made of two plates, lap jointed and single riveted, and originally $\frac{5}{16}$in. thick. The firebox appears, however, to have been severely wasted by corrosion, and over an area measuring roughly 12in. square the plate was reduced to the thickness of a sixpence, and thereby rendered too weak to resist the ordinary working pressure, which was stated to have been 40lb. on the square inch. Although it is very improbable, looking at the defective condition of the firebox, that this pressure was exceeded, yet it may be pointed out that the safety valve with which the boiler was fitted was loaded by means of a lever and spring balance, and the report states that the working pressure could be exceeded by 50 per cent by merely screwing down the compressing nut of the balance.

The danger of loading safety valves with spring balances unless fitted with proper stop ferrules, or otherwise arranged to prevent overloading, is a point to which we have on prior occasions called attention. It would appear, however, that a word of caution with regard to these appliances is still called for, and we therefore take this opportunity of stating that a safety valve which can be rendered inoperative by a few turns of the thumb nut on the part of a reckless or ignorant attendant is a delusion and a snare, and a safety valve only in name. The application of such a fitting to a steam boiler is the less excusable as the risk of overloading can be so readily avoided, either by the application of a suitable ferrule, or a proper adjustment of the point of attachment of the casing of the balance.

Mr. Traill, chief engineer to the Board of Trade, in commenting on the explosion, animadverts rather strongly on the defective safety valve arrangements frequently adopted in this class of boiler, as well as the unsatisfactory conditions under which they are worked. His remarks are not one whit too strong, and we have personally more than once seen boilers of this type with the safety valve (of the spring balance type) screwed down hard and fast, and for all practical purposes useless.

External Firing.—Wilful Recklessness of Attendant.

Report No. 270 deals with the explosion of a plain cylindrical egg-ended boiler that occurred at the Capponfield Ironworks, Bilston, on April 21st. The boiler, which measured about 40ft. in length by 8ft. diameter and $\frac{7}{16}$in. in thickness, formed one in a group of six, and was fired with the waste gases from some blast furnaces. It had the usual fittings, including a lever safety valve, loaded to a pressure of 25lb. on the square inch.

The report states that the boiler gave way in the first instance at the front egg end, where it had been patched. The rent continued in a longitudinal direction through the solid metal of five belts of plating, after which it branched into a circumferential seam, and ran in an irregular manner completely round the shell. The front end of the boiler was lifted up, and the boiler, turning about its back end, was reversed in position and thrown on a bank.

The immediate cause of the explosion is attributed to shortness of water, though the Board of Trade surveyor is of opinion that the plates which first gave way were much deteriorated by the action of the heated gases, which were allowed to impinge directly upon them.

From the evidence given at the preliminary inquiry, it appears that the boilers were fed with water of a very sedimentary character, which frequently interfered with the working of the feed pump, and that at the time of the explosion the engine pump was disabled and the boilers had been working with the feed shut off for about 3¼ hours. The attendant appears to have acted with a recklessness amounting almost to criminality, for although aware that the water level in the boilers was very low, he did nothing to check the admission of the gases to the gases, but on the other hand actually disconnected the alarm whistles in order to avoid attracting attention.

The report recommended that such boilers should be fitted with glass water gauges, instead of reliance being placed solely on the action of wheelfloats and whistles. Looking, however, at the gross negligence displayed by the attendant, it is very questionable whether the application of these fittings even would have prevented this explosion, the responsibility of which appears to us to lie wholly with the man in charge.

A Trivial Case.

Report No. 271 deals with a case which can hardly, by any straining of terms, be characterised as an explosion, and simply records the fact that the uptake of a small vertical boiler was corroded through in two places, forming two small holes, through which the steam escaped; the holes, however, were so slight that their dimensions are apparently not thought worthy of record in the report, and we simply refer to the case in order that steam users may judge of the elements that enter into the statistics of boiler explosions occasionally provided for their delectation.

Failure of a Screwed Nipple.

Report No. 272 refers to the failure of a wrought-iron nipple, 1⅛in. diameter, connecting a small brass check valve to the front of a Cornish boiler. The failure occurred in consequence of the nipple being wasted by corrosion, and, had it not been that the rush of steam which occurred resulted in three men being scalded, probably nothing would have been heard of the case.

Drying Cylinder.—Defective Reducing Valve.

Report No. 273 deals with the bursting of a steam drying cylinder at the Leyland Rubber Works, near Preston, on May 14. The cylinder, which measures 6ft. in diameter by 5ft. 6in. in length, was made of tinned sheet iron, about one-twentieth of an inch in thickness, and was worked at a pressure of about 6lb. on the inch. The steam was supplied through a pipe 1in. in diameter connected to the main boilers, which were worked at 50lb. on the inch, the pressure being regulated by means of a reducing valve. The cylinder was fitted with two valves, which opened automatically when the pressure in the cylinders fell below that of the atmosphere, and thus prevented the risk of collapse, but there was no safety valve attached to prevent the pressure becoming excessive, reliance being placed solely upon the efficient action of the reducing valve. This fitting, as has more than once happened with this class of apparatus, proved inoperative in consequence of the valve sticking, the result being that the pressure in the cylinder accumulated until it burst, and then inflicted considerable damage upon the roof and windows of the building in which it was situated.

This is not by any means the first explosion of drying cylinder that has arisen in this way; indeed a considerable number have come under our own personal observation, almost everyone being due to the same cause, viz., excessive pressure in consequence of the defective condition of the reducing valve and the absence of any safety valve to afford relief, or pressure gauge to give warning. Considering the careless manner in which these drying cylinders are often worked, the wonder to our minds is that failures are not more often recorded. The report points out that to render the working of such vessels safe they should either be made strong enough to resist the highest pressure likely to be brought upon them, or else fitted with a safety valve of good design, and fully adequate to prevent any rise of pressure, while it is always to fit a reliable pressure gauge. This recommendation we strongly endorse, and there can be little doubt that if it had been adopted in the present case the explosion would not have occurred.

Glasgow Exhibition.—The admissions on Saturday last amounted to 75,190, making a total of 4,061,481. The fifth million of visitors has thus begun on the 119th day. In the case of the London and Manchester Exhibitions this stage was not reached until the 124th and 146th day respectively.

COMBINING INDICATOR DIAGRAMS OF COMPOUND ENGINE.—I.

In the consideration of the action of the steam in the different cylinders of compound engines, it is occasionally useful and instructive to combine the diagrams when these are reduced to the proper scales of pressures and volumes. This, however, is frequently done without any appreciation of the points to be considered; and, indeed, noting how often such combined diagrams are introduced into text books and papers on the compound engine, the paucity of information with regard to the method of combining the diagrams is remarkable.

Rankine, in his work on the steam engine, explains the method to be pursued in a theoretical case, which we illustrate in fig. 1. In this, ABCD represents the diagram from the high-pressure cylinder, and AFE that from the low-pressure cylinder. The ratio of OP to ON is what is commonly known as the cylinder ratio, and the pressures in each diagram are on the same scale. To combine these diagrams, draw a horizontal line KGH, cutting the two diagrams in K and H. Then, assuming that there is no loss between the cylinders, it follows that when the pressure is equal to OG, the steam occupies a volume GH in the small cylinder, and a volume GK in the large cylinder. Set off HL equal to GK. Then the total volume of the steam at that pressure is represented by the line GL, and L is a point on the combined diagram. By repeating this construction at different pressures the curve DM is completed, and the diagram ABCM is obtained, which represents the expansion of steam when supposed to take place in the large cylinder only.

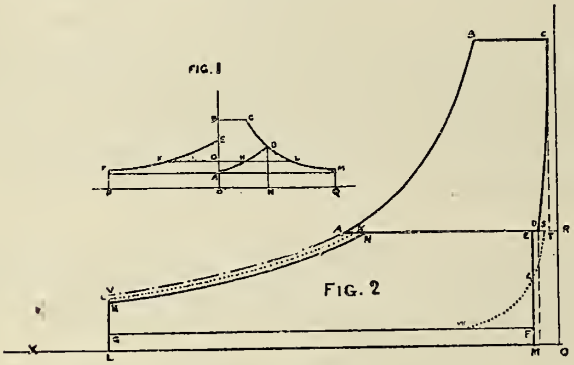

FIG. I

FIG. 2

This is the only case considered by Rankine, and represents a wholly ideal state of things—the cylinders being supposed to have no clearance, there being no receiver space between them; the steam suffering no loss of pressure between the cylinders, and no compression taking place in either cylinder; while the communication is open between the cylinders for the full stroke, the engine evidently being intended to represent what is known as the Woolf type of engine. On attempting to utilise the above construction in an actual case the difficulties caused by the above assumptions at once make themselves felt, and one of the most evident of these is the fact that in actual practice there is always a loss between the cylinders; that is to say, that even when the cylinders are in communication the steam in the first cylinder is always at a higher pressure than that in the second cylinder.

The action of the steam during the period that one part of it is at a different pressure to the other cannot be properly represented on one diagram, for one of the first conditions which render any diagram intelligible is the assumption that at any time the curve represents the state of things in the whole volume of steam under consideration, and that the pressure throughout the steam is at any particular moment the same. This assumption, however, can only be made when the steam is wholly in one or other of the cylinders, and this condition only holds between the cutting off of the steam and the opening of the exhaust in each cylinder. It is, therefore, only between these points that the combined diagram offers facilities for comparing the actual and theoretical volume and pressure of the steam.

It is usually the practice to compare the actual expansion of the steam with that of a gas expanding according to the law pv = a constant, and in combining the actual diagrams the course commonly pursued is to set the high-pressure diagram at the distance of its clearance from a vertical line, and the low-pressure diagram at the distance of its clearance from the same vertical. An hyperbola is then drawn touching the high-pressure diagram, and the departure of the actual low-pressure expansion line from this curve is assumed, without further consideration, to represent the deviation of the expansion of the steam from the law pv = a constant.

This course is indicated in fig. 2. DCBA represents the high-pressure diagram, AT = volume of high-pressure cylinder (*i.e.*, volume swept through by piston), and TR = clearance of high-pressure cylinder. The high-pressure exhaust closes at D, and DC is the compression line. ER is the clearance of the low-pressure cylinder, and we have supposed, in the first case considered, that the low-pressure exhaust remains open for the whole return stroke. For simplicity, the high-pressure exhaust line is taken as coinciding with the low-pressure admission line. Then during the return stroke of the high-pressure cylinder, a volume of steam AD (= the whole cylinder and clearance AR, minus the volume DR compressed) is discharged into the low-pressure cylinder. This has to fill a part of that cylinder, including the whole of the clearance ER. Set off NR equal to AD, then evidently NR will be the volume occupied in the large cylinder, and of this ER is only clearance space; hence EN will be the part of the total volume discharged from the small cylinder, which appears on the low-pressure diagram GFENH.

It will be seen that in this case we have the low-pressure diagram placed in the usual way, at the distance of its clearance ER from the vertical OY, and we have supposed that the steam throughout its expansion has followed the hyperbolic law; yet under these conditions the theoretical expansion line of the low-pressure diagram does not lie in the continuation of the high-pressure hyperbola, but in an hyperbola passing through N at a distance from it of AN = ER = the low-pressure clearance.

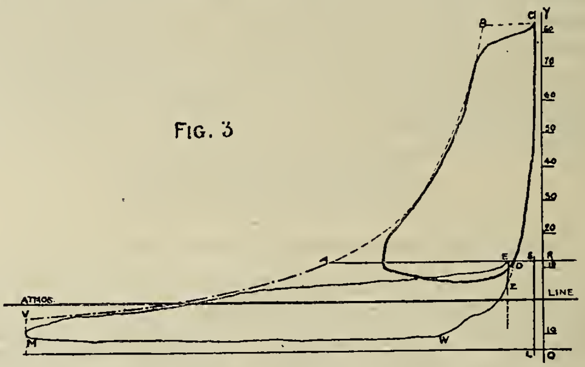

FIG. 3

Suppose, again, that the low-pressure exhaust closes at W, the back-pressure being FM, the steam will be compressed along the curve WZ, and continuing this curve to S, it is seen that at the end of the low-pressure return stroke we have steam shut up in the clearance equal to a volume RS at the pressure OR. In this case, to find the volume occupied in the large cylinder by the steam discharged from the high-pressure cylinder, set off SK equal to DA, then KR will be the total volume of steam shut up in the large cylinder and clearance, and of this a volume EK will be shown on the diagram EKLGWZ. Here, again, it will be seen that the expansion line falls below the high-pressure expansion, and a further examination of the figure will show that the condition of the low-pressure expansion following the continuation of the high-pressure curve is that the amount of steam compressed in the low-pressure cylinder is equal to DR, *i.e.*, is equal to that compressed in the small cylinder.

(To be continued.)

THE FIRST CENTURY OF THE MARINE ENGINE.—VI.

(Concluded from page 451.)

The complete efficiency of a marine engine is the resultant of the separate efficiencies of the boiler, the steam, the mechanism, and the propeller. To give a rough idea of the value of this, the first of these components may be assumed at ·6, the second at ·2, and the third and fourth combined at ·5, so that the resultant efficiency is ·06—that is to say, that only about one-sixteenth of the energy of the fuel is utilised in the propulsion of the vessel; so that, notwithstanding the progress which has been made during the first century of the marine engine, there is still a wide field for the ingenuity of the engineer and shipbuilder.

As it has been already remarked, what shipowners care about is the consumption of coal per ton carried, and the speed at which it is carried; and the following figures will be sufficient to indicate the progress which has been made since ocean navigation was firmly established.[*] The first steamers of the Cunard Company were under contract to go at a speed of 8½ knots; they indicated 740 horse power, and consumed 4·7lb. of coal per I.H.P. The speed and power were increased from time to time, and when the Americans put on the Collins Line, it was found necessary to build steamers which went 12 to 12½ knots, indicating 2,000 horse power, and consuming a fraction under 4lb. per I.H.P. These steamers made the passage, on an average, in 12 days 9 hours outwards, and 11 days 11 hours homewards; but as this was somewhat longer than the time taken by the American line, another step had to be taken in advance, and the Persia, an iron paddle steamer, was built in Glasgow in 1856. This vessel performed her voyage between Queenstown and New York, on an average, in 10½ days. She was fitted with side-lever engines indicating 3,600 horse power, and consuming 3·7lb. of coal per I.H.P. She attained an average speed of 12·9 knots, and consumed 150 tons of coal per day. The Gallia, belonging to the same company, was built on the Clyde in 1879, and was fitted with compound engines indicating 5,000 H.P., and consuming only 97 tons of coal per day. She accomplished the passage in a little under eight days, her average speed being about 15½ knots, and she carried, besides her passengers, fuel, stores, &c., 1,700 tons weight of cargo. Comparing this with the Persia, we find that this vessel burned 6·3 tons of coal for every ton of cargo she carried, while the Gallia burns something less than half a ton of coal for every ton of cargo she delivers, and, moreover, she carries it 2½ knots faster. In the Arizona, also built in 1879, the indicated horse power is 6,000, and she burns 5 cwt. of coal for every ton of cargo she carries, which she does at a speed of over 16 knots. Since 1879 many large steamers have been placed on the Liverpool and New York lines, and the passage is now accomplished in a little over six days, at a still further reduction of coal per ton of cargo carried.

The great economy in coal which has taken place during the last decade has made it possible to steam from London to New Zealand without calling to replenish coal, and it was in such voyages that the triple-expansion engine was first employed. As illustrating the economy of that type of engine, Mr. Parker has given[†] the following example: Two large passenger steamers of over 4,500 tons gross tonnage, having engines of about 6,000 I.H.P., built of the same dimensions, from the same lines, with similar propellers, are exactly alike in every respect except so far as their machinery is concerned. One vessel is fitted with triple-expansion engines, working at a pressure of 145lb. per square inch, while the other vessel is fitted with ordinary compound engines, working at a pressure of 90lb. per square inch. Both vessels are engaged in the same trade, and steam at the same rate of speed, viz., 12 knots per hour. The latter vessel, on a round voyage of 84 days, burns 1,200 tons more coal than the former."

The subject of the resultant efficiency of steamships is beyond the scope of this paper, but still the following extract from a speech by Mr. Sutherland (chairman of the P. and O. Company), at a meeting of the shareholders, will give some indication of the progress which has been made during the past ten years. He said: "It is a fact that during the last few years there has been a steady reduction in the expenditure of the company in proportion to the amount of work performed. By way of illustrating what I say, I may mention that ten years ago, in 1877, I find that our expenses per mile navigated, including all normal and current charges, insurance and depreciation, were at the rate of 22s. 3d. per mile, whereas last year the same expenditure was at the rate of 18s. per mile only; but mark with this very great difference in the character of the work done: I may say, almost the same number of vessels as were employed ten years ago are employed now, but the tonnage of these vessels has been increased by between 50,000 and 60,000 tons, and therefore we have been working these larger vessels at that reduced rate of cost. Again, the increase in speed of our ships, as compared with ten years ago, has been between 16 and 20 per cent. Therefore, the mere difference of 4s. per mile conveys a very inadequate idea of the absolute reduction of expenditure in proportion to the extent and character of the work done." This latter fact is, of course, evident, for the figures given by Mr. Sutherland only include one of the variables of the problem. Cost per mile run is not sufficient to make an approximation to exactitude; we ought to know cost per mile per ton of freight carried per day. The subject of the efficiency of steamships from the owners' point of view is, however, a very large one, and time will not allow us to enter into it further at present.[‡]

For the same reason we cannot enter into statistics showing the effect of the development of the marine engine on the progress of steam navigation. Moreover, the very complete returns of the Board of Trade, and such publications as Lord Brassey's "Naval Annual," give in a convenient form all the information which is likely to be wanted regarding the merchant service and British and foreign navies respectively, and its repetition is unnecessary.

ENGINE TRIALS OF H.M.S. SANSPAREIL.

The armour-plated battleship Sanspareil, which was launched by the Thames Ironworks and Shipbuilding Company at Blackwall on the 9th of May last year, made highly satisfactory trials of her engines at the Nore on Thursday and Saturday last, under the superintendence of Mr. Robert H. Humphrys, of the firm of Messrs. Humphrys, Tennant, and Co., of Deptford, who are the manufacturers of the machinery.

The Sanspareil is in every respect a sister ship to the Victoria, while her engines, which were built by Messrs. Humphrys, Tennant, and Co. last June, are of the same triple-expansion type. The ships are the quickest and most powerfully armed, and, with two or three exceptions, the heaviest battleships in the service.

To descend to particulars, it may be stated briefly that the vessels measure 240ft. by 70ft., have a displacement of 10,470 tons, carry a brace of 10-ton guns in their single turrets, and are armoured to the thickness of from 16in. to 18in. at the sides, and 16in. at the bulkheads, while the turrets are constructed of 18in. compound plates.

The engines are contracted to develop 12,000 horses under forced draught, and are designed to propel the vessels at a speed of 17 knots when exerting their maximum power; while the consumption of fuel is so small, comparatively, that the 1,200 tons of coal which their bunkers are capable of stowing will, it is estimated, be sufficient to enable the ships to steam 7,000 knots, or from England to New York and back, at the rate of 10 knots. The Sanspareil left the Nore at half-past nine on Thursday morning week, for four hours' continuous steaming with open stokeholds, the following being the mean results of the trial: Steam pressure in boilers, 133·57lb.; vacuum, 27½in.; port and starboard revolutions, 87·37 and 86·86 per minute; indicated horse power, 4,109·76 (port) and 3,929·66 (starboard), giving a collective indicated power of over 8,000. This total was more than 500 horses in excess of the contract, the mean speed of ship as measured by patent log, being 16 knots.

The more important trial, with closed stokeholds, came off on Saturday under very favourable auspices as regards the weather, the five hours run, with regard both to the sea and to the working of the machinery, being of the character of a pleasure trip. The Sanspareil was immersed to a mean draught of 26ft. 9in.—her sea-going trim—by water and iron ballast, so that the conditions of the steaming may be regarded as of a practical character. The ship got under way at 9-15 in the morning, and in the short space of half an hour, everything going well and with an abundance of steam, the contractors were ready to begin the official observations, of which the following are the hourly returns:—

Revolutions.		Indicated Horse Power.		Collective Power.
Starboard.	Port.	Starboard.	Port.	
100·5	100·0	7,177·16	7,126·99	14,304·15
101·4	101·6	7,363·04	7,469·21	14,832·25
101·6	101·6	7,264·94	7,396·43	14,661·37
99·8	100·0	7,060·82	7,072·49	14,133·31

The means of the observations gave the following data: Steam pressure in boilers, 130lb.; mean air pressure in stokeholds, 1·9in. of water; vacuum in condensers, 26in.; mean revolutions, 100·76 starboard and 100·7 port; mean indicated horse power, 7,216·49 starboard and 7,266·28 port, being equal to a collective power of 14,482·77. Extraordinary as were the results achieved at the trial of the sister ship, the trial of the Sanspareil not only confirmed but surpassed them.

The mean collective power indicated by the Sanspareil showed a gain of no less than 2,482·77 above the contract. The average speed realised on the occasion was 17·75 knots. On the conclusion of the run the Sanspareil was circled to port and starboard, and the engines were tested for stopping, starting, and going astern, with very satisfactory all-round results.

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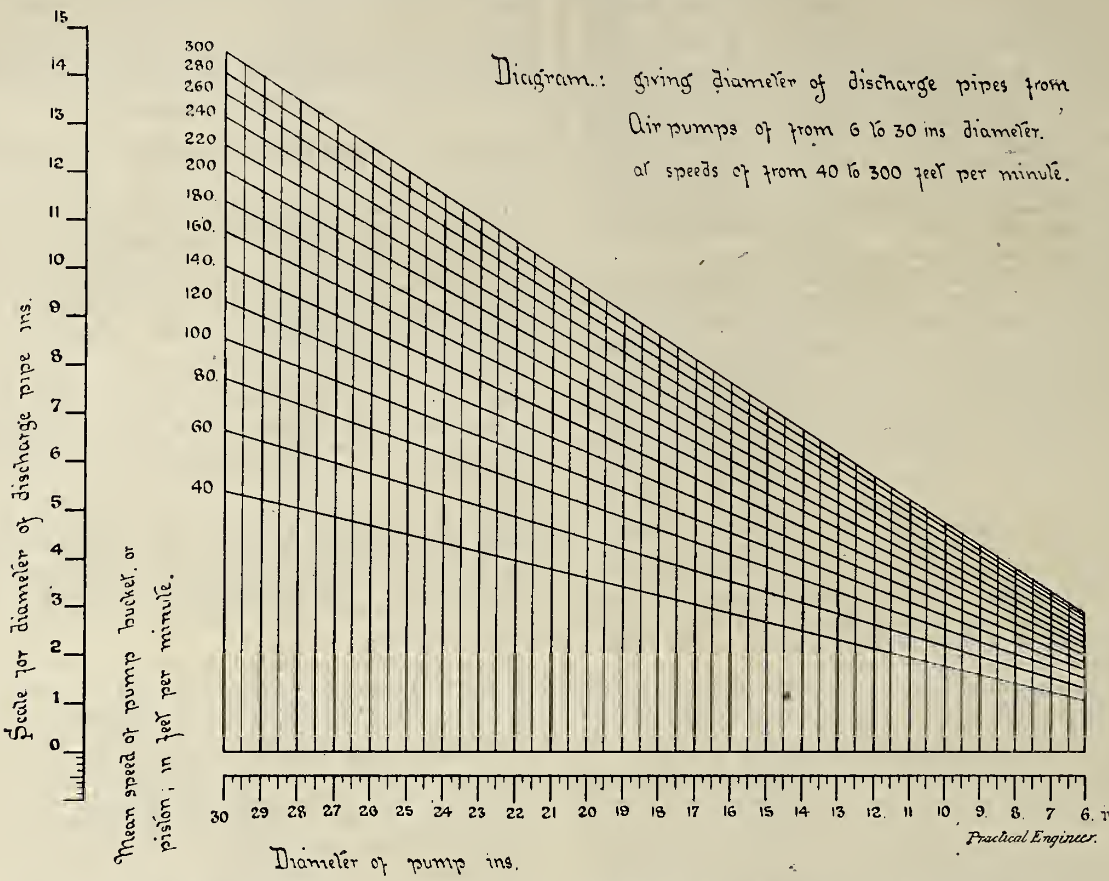
[*] Chiefly from a lecture by Sir William Pearce, delivered during Naval and Marine Engineering Exhibition at Glasgow, 1880-81.

[†] Transactions Inst. N. A., vol. xxviii., p. 129.

[‡] On this subject a lecture was recently delivered by the author of this paper before the Clyde Steam and Sailing Shipowners' Associations, in which the various factors of the problem were discussed.

PUMP CONNECTIONS.—II.

(Continued from page 379.)



The Air Pump.

In our issue of August 10th last we gave a diagram showing the diameter of the delivery pipe from feed pumps, to supplement which we give this week on the present page a diagram giving the diameter of the discharge pipe from air pumps of from 6in. to 30in. in diameter, running at speeds of from 40ft. to 300ft. per minute, and we think at the same time a few words as to the arrangement of the connections might be of service to many.

In the first place, too much care cannot be bestowed on the proportioning and arranging of the air-pump valves and connections, for on this depends to a large extent the successful working of the pump.

The most important conditions that should be observed are:—

1. The flow of the water, on its way from the condenser to the hot well, should be as direct as possible, and of a uniform velocity.

2. The valves should open with the least possible pressure under them, and still readily close on the return stroke, for the foot valves can only open by the pressure under them being greater than that on them, so that if there is not a sufficient head of water, as in the case of surface condensers, it depends entirely on the pump forming a better vacuum between the foot and head valves than there is in the condenser. To do this requires the pump to work with high efficiency, as, if the vacuum in the condenser be good, there can be but little difference between the pressure in the condenser and that in the pump chamber, so that if the valves have much resistance in themselves they will cease to act. In considering this point it must be borne in mind that the pressure in the pump chamber must vary from a little above atmospheric pressure, when the head valves are open, to below that in the condenser, to allow the foot valves to open. By reason of this the space between the foot and head valves must not be more than one-fifteenth the capacity of the pump, or it will be impossible to obtain a good vacuum in the condenser. This clearance space can, however, be virtually reduced by filling it with water, as is often done in the case of horizontal pumps working in connection with surface condensers, by fitting a small pipe, say about one-eighth the diameter of the pump, to connect the space between the valves with the hot well, having a non-return valve fitted to it, so that to some extent the tinuously charged. The area of the opening past the valves should be such as to allow of the full quantity of water required for jet condensation passing at a velocity not exceeding 400ft. per minute. If the foot valves are large they will not act promptly, whereas, on the other hand, if small, the velocity of the water, &c., will be high enough to raise the valves and keep them open by the energy of the particles striking them. The head valves should be so arranged that water lodges on them, so that should they leak only water escapes back into the pump; also they should be above the pump barrel, to prevent air lodges. Double-acting air pumps require suction and discharge valves, but it is possible to do without a foot valve or head valve in the case of a bucket pump. An air pump with a foot valve and no discharge valve would be most affected by a leaky air-pump rod stuffing box, because the atmosphere would press on the bucket valves, and would not allow of their rising readily off their seats, and would also cause the pump to work very irregularly, sometimes not drawing, and other times gorging itself with water; whereas in the case of the air-pump rod or trunk passing through the head valve, a leaky stuffing box would have no effect on the working of the pump, either with a foot valve or without one; but in the case where the delivery valve is on the side of the pump, the leaky stuffing box would affect the working of the pump considerably, even if fitted with a good valve, but without one the pump would not work at all, because the bucket valve would not leave its seat, owing to the atmospheric pressure acting above it, and there being a vacuum beneath.

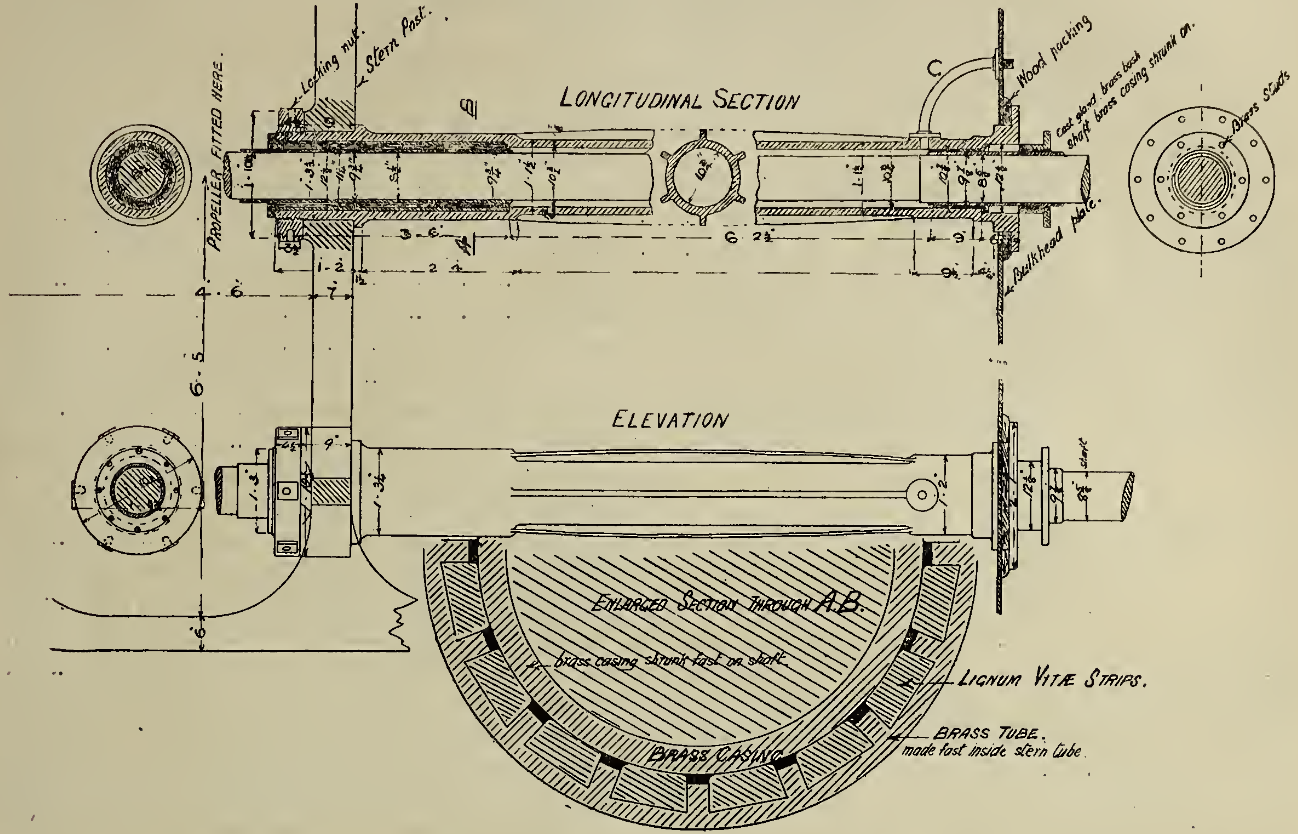
3. The foot valve should be below the lowest level of the condenser, so that the water shall readily drain from the condenser into the pump, and the passage should be inclined so that the water naturally flows in that direction.

Note 1.—Referring to the diagram, if there is no air vessel or receiver to the pump, as in the case with some double-acting pumps, the discharge pipe should be 10 per cent larger in diameter.

Note 2.—An air pipe should always be fitted to the hot well as high up as possible, and of a diameter one-quarter that of the discharge pipe.

Note 3.—In the case of a vertical pump fitted with trunk, if the trunk be made half the area of the bucket, it becomes virtually a double-acting pump so far as the discharge is concerned, and the diameter of the pipe should be calculated accordingly.

STERN TUBE FOR PROPELLER SHAFT.



The accompanying illustrations, showing the method of fixing the propeller shaft in the stern tube of a steamship, have been kindly sent us by a correspondent in answer to a query which appeared on page 431 in our issue of September 7th. Judging from several letters we have received, the query appears to have been of considerable interest, and we trust the accompanying detailed drawings will prove of service.

The function of the stern tube, as our readers will be aware, is to enclose and support the outer end of the last length of the propeller shaft. In the navy the stern tube is always of brass, and in iron and composite ships is within another wrought-iron tube, secured to the framing of the ship. The lignum-vitæ strips are fitted into the tube either in separate grooves for each strip, or the strips fit side by side with a brass strip at the top, secured by screws to the tube which keys them, so as to form a bush. A similar but shorter set of strips are fitted next the stuffing box. The brass stern tube fits into the stern post accurately and tightly, and is secured to the bulkhead by a flange, &c.

In the mercantile marine the stern tube is nearly always of cast iron (see illustration), whose thickness is 0·1 the diameter. The stern bush, of brass, fits accurately into the tube, and the stuffing-box neck, ring, and gland are lined with brass. There are various ways of fitting the stern tube in place. The common plan adopted by most engineers is to turn the outer end, so as to fit tightly into the hole bored in the stern post, and secure it by a nut screwed on its end. (The nut illustrated has holes in it to fit a long half-claw spanner.)

The inner end of the stern tube has a flange, and next it a projecting rim, which is turned to fit in the hole bored in the bulkhead, the flange being bolted to the bulkhead after a liner is fitted between them.

The stern tube is sometimes bolted to the stern post by two lugs cast with it, one above and one below it. Another plan of fixing the stern tube is to fit its outer end into a recess bored in the stern post, and secure it by bolts to the bulkhead, as before described, and by two strong drawbolts passing through the flange to a partial bulkhead two or three frame spaces nearer the stern. In this case the stern bush is partly in the tube and partly in the stern post.

When the stern bushes are made of white metal, they should be of a thickness = 0·5in. + 0·03 × diameter. Those fitted with lignum-vitæ are of brass, and formed with a flange, as shown, which is secured to the stern tube by countersunk headed screws, which prevent it from turning or coming out. The lignum-vitæ is fitted in brass stern tubes, but sometimes it is fitted in square holes, the bush being cast as a skeleton to hold the wooden blocks. This latter plan is very convenient for small ships, but not a good one for large ones, as the wood, by the continued concussion, gets impressed on the cast-iron tube. Lignum-vitæ, as a rule, wears best when bearing endway of the grain, especially when it is of inferior quality; when cut from a good tree of large size it wears almost equally well either way. The lignum-vitæ strips should be from ⅝in. to ⅞in. thick, and about 3 to 4 times their thickness in breadth; they must be bevelled or spaced apart, as shown, so as to leave free water-courses between them. The brass behind the strips should be 0·04 × diameter in thickness, and the metal ridges between the strips of the same thickness. Sometimes the brass bush is dispensed with, and the strips fitted into the cast-iron tube, as in the brass tube. A pipe marked C is fitted leading from the top of the stern tube to the bulkhead, through which the water may run from the tube, so as to cause a fresh supply to enter from the sea, and thereby prevent heating.

The tube shown in the illustrations represents one in actual work in a steamship of the following dimensions: Length 220ft., breadth 31ft. 6in., depth 14ft. 5½in., the engines being of the two-cylinder compound condensing type, H.P., 26in. diameter, L.P. 50in. diameter, stroke 3ft., revolutions 72 per minute, boiler pressure 80lb.

The Source of Amber.—The only place in which amber in paying quantities has been found is the Baltic Sea, and the vein extends from Western Russia to Denmark, Norway, and Sweden. Formerly the supply depended on the storms, which tore up the amber lying at the bottom of the sea, and threw it on shore; but for twenty-five years past various appliances have been used for obtaining it cheaply and quickly. The most profitable *strata* have been found in the vicinity of Memel, and there are twenty large dredging boats constantly at work day and night for eight months of the year. Large strings of pails are constantly dragging along the bottom and bringing up sand, which is washed for the amber. Further to the west the amber is obtained by divers, who go down with diving apparatus and remain below for four or five hours. Each diver has a little bag round his neck, and a peculiar hook, with which he pulls up the sand, and every piece of amber that he finds is thrown into the bag. Amber is also mined, for the *stratum* of green sand in which it is found extends about thirty miles inland. In these mines there are about forty miles of passages, while 700 men are employed in the various departments. The miners simply cut the sand and load it in trucks; it is then brought to the surface, where it is thrown into a long trough filled with rushing water, which separates the amber. The latter is caught by nets of various sizes, is then cleaned by machinery, and assorted according to its quality and purity.

MARINE ENGINE CRANK AND SCREW SHAFTING.

TABLE GIVING DIAMETER OF CRANK AND PROPELLER SHAFTS FOR TRIPLE-EXPANSION ENGINES, WORKING AT 150lb. GAUGE PRESSURE PER SQUARE INCH.

(Constructed in accordance with Lloyd's Formula for the same.)

(Continued from page 416.)

Stroke in inches.	Diameter of Low-pressure Cylinder in Inches.																													
	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
33	9⅛	9¼	9⅜	9½	9⅝	9 11/16	9⅞	9 15/16	10 1/16	10 3/16	10 5/16	10⅜	10½	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
34	9¼	9 5/16	9 7/16	9 9/16	9 11/16	9 13/16	9 15/16	10 1/16	10 3/16	10¼	10⅜	10½	10⅝	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
35	9 5/16	9 7/16	9 9/16	9 11/16	9 13/16	9 15/16	10	10⅛	10¼	10⅜	10½	10⅝	10 11/16	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
36	9⅜	9½	9⅝	9¾	9⅞	10	10⅛	10¼	10⅜	10½	10 9/16	10 11/16	10 13/16	10 15/16	11 1/16	11 3/16	11¼	..	..	..	..	..	..	..	..	..	..	..	..	..
37	9½	9⅝	9¾	9⅞	10	10 1/16	10 3/16	10 5/16	10 7/16	10 9/16	10 11/16	10 13/16	10 15/16	11	11⅛	11¼	11⅜	..	..	..	..	..	..	..	..	..	..	..	..	..
38	9 9/16	9 11/16	9 13/16	9 15/16	10 1/16	10 3/16	10 5/16	10 7/16	10 9/16	10 11/16	10¾	10⅞	11	11⅛	11¼	11⅜	11½	11 9/16	11 11/16	11 13/16	..	..	..	..	..	..	..	..	..	..
39	9⅝	9¾	9⅞	10	10⅛	10¼	10⅜	10½	10⅝	10¾	10⅞	11	11⅛	11¼	11⅜	11 7/16	11 9/16	11 11/16	11 13/16	11 15/16	..	..	..	..	..	..	..	..	..	..
40	9¾	9⅞	10	10⅛	10¼	10⅜	10½	10⅝	10¾	10⅞	10 15/16	11 1/16	11 3/16	11 5/16	11 7/16	11 9/16	11 11/16	11 13/16	11⅞	12	12⅛	12¼	12⅜	..	..	..	..	..	..	..
41	9 13/16	9 15/16	10 1/16	10 3/16	10 5/16	10 7/16	10 9/16	10 11/16	10 13/16	10 15/16	11 1/16	11 3/16	11 5/16	11 7/16	11½	11⅝	11¾	11⅞	12	12⅛	12¼	12⅜	12½	..	..	..	..	..	..	..
42	9⅞	10	10⅛	10¼	10⅜	10½	10⅝	10¾	10⅞	11	11⅛	11¼	11⅜	11½	11⅝	11¾	11⅞	12	12⅛	12¼	12⅜	12½	12⅝	12¾	12⅞	..	..	..	..	..
43	10	10⅛	10¼	10⅜	10½	10⅝	10¾	10⅞	11	11⅛	11¼	11⅜	11½	11 9/16	11 11/16	11 13/16	11 15/16	12⅛	12¼	12⅜	12½	12⅝	12⅝	12¾	13	..	..	..	..	..
44	..	..	10 5/16	10 7/16	10 9/16	10 11/16	10 13/16	10 15/16	11 1/16	11 3/16	11 5/16	11 5/16	11 9/16	11 11/16	11 13/16	11 15/16	12⅛	12¼	12⅜	12⅜	12½	12⅝	12¾	12⅞	13	..	..	..	..	..
45	..	..	10⅜	10½	10⅝	10¾	10⅞	11	11⅛	11¼	11⅜	11½	11⅝	11¾	11⅞	12	12⅛	12¼	12⅜	12½	12⅝	12¾	12⅞	13	13⅛	13¼	13⅜	..	..	..
46	..	..	..	..	..	..	11	11⅛	11¼	11⅜	11½	11⅝	11¾	11⅞	12	12⅛	12¼	12⅜	12½	12⅝	12¾	12⅞	13	13⅛	13¼	13⅜	13½	..	..	..
47	..	..	..	..	..	..	..	11 3/16	11 5/16	11 7/16	11 9/16	11 11/16	11 13/16	11 15/16	12⅛	12¼	12⅜	12½	12⅝	12¾	12⅞	13	13⅛	13⅛	13¼	13⅜	13½	..	..	..
48	..	..	..	..	..	..	..	11¼	11⅜	11½	11⅝	11¾	11⅞	12	12⅛	12¼	12⅜	12½	12⅝	12¾	12⅞	13	13⅛	13¼	13⅜	13½	13⅝	..	..	..
49	..	..	..	..	..	..	..	..	..	..	11¾	11⅞	12	12⅛	12¼	12⅜	12½	12⅝	12¾	12⅞	13	13⅛	13¼	13⅜	13½	13⅝	15¾	13⅞	14	14⅛
50	..	..	..	..	..	..	..	..	..	..	11 13/16	11 15/16	12⅛	12¼	12⅜	12½	12⅝	12¾	12⅞	13	13⅛	13¼	13⅜	13½	13⅝	13¾	13⅞	13⅞	14	14⅛
51	..	..	..	..	..	..	..	..	..	..	..	..	..	12¼	12⅜	12½	12⅝	12¾	12⅞	13	13⅛	13¼	13⅝	13½	13⅝	13¾	13⅞	14	14⅛	14¼
52	..	..	..	..	..	..	..	..	..	..	..	..	..	12⅜	12½	12⅝	12¾	12⅞	13	13⅛	13¼	13⅜	13½	13⅝	13¾	13⅞	14	14⅛	14¼	14⅜
53	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	13	13⅛	13¼	13⅜	13½	13⅝	13¾	13⅞	14	14⅛	14¼	14⅜	14½
54	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	13½	13⅝	13¾	13¾	13⅞	14	14⅛	14¼	14⅜	14½
55	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	13⅝	13¾	13⅞	13⅞	14	14⅛	14¼	14⅜	14½	14⅝
56	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	13⅝	13¾	13⅞	14	14⅛	14¼	14⅜	14½	14⅝	14¾
57	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	14	14¼	14¼	14⅜	14½	14⅝	14¾
58	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	14⅜	14½	14⅝	14¾	14⅞
59	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	14½	14⅝	14¾	14⅞	15
60	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	14½	14⅝	14¾	14⅞	15

In our issue for August 31st, page 416, we gave an article on the above subject, accompanied by a table showing at a glance the diameter of crank and propeller shafts for triple-expansion engines working at a pressure of 150lb., when constructed in accordance with Lloyd's formulæ. That table showed the diameter of the shafts for engines, with low-pressure cylinders ranging from 30in. to 50in. diameter, and strokes varying from 18in. to 39in.

We now have pleasure in furnishing an extension of the table for cylinders ranging from 51in. to 80in. diameter, and with strokes varying from 33in. to 60in. in length.

Wages in the Midland Iron Trade.—At a meeting of the Midland Iron and Steel Wages Board, held in Birmingham on Monday last, the Chairman stated that the employers had come to the conclusion that their contributions did not equal those of the operatives, and it was resolved that the employers' subscriptions be raised from 1s. to 1s. 6d. for each ball furnace, and from 2s. to 3s. on each mill forge. The ironworkers next submitted a claim for an advance in wages, arguing that the condition of trade warranted an increase of 12½ per cent. The Chairman, speaking for the employers, said they did not think that the time had arrived when wages could be advanced, as they were subjected to very severe competition from the North of England and Scotland. A delegate stated that there was a strong feeling amongst the men that an advance should be made. Ultimately, it was resolved to refer the matter to the arbitrator, Sir Thomas Martineau.

THE RUSTING OF IRON.*

In this short paper there is, so far as I know, no new fact described. I believe everything, or nearly everything, in it is to be found in the records of chemical research; but as I find that the process involved in the rusting of iron is often misunderstood, I have thought it might be worth while to put together the known facts in their connection. My attention was first called to the subject by observing what happens when a drop of rain falls on a clean bright surface of iron. At first, for a short time, the drop remains clear, and the bright surface of the iron is seen through it; but soon a greenish precipitate forms in the drop, and this rapidly becomes reddish brown. The brown precipitate does not adhere to the iron, but is suspended in the water, and becomes a loosely adherent coating only when the water has evaporated.

I may premise that, in speaking of rusting, I mean the formation of rust on the surface of metallic iron exposed to ordinary atmospheric conditions. I do not intend to treat of the corrosion of iron by substances such as sulphuric or sulphurous acid, hydrochloric acid, or any other occasional impurities which may be present in air.

It has been conclusively shown that the necessary conditions for the production of rust are: (1) metallic iron, (2) liquid water, (3) oxygen, and (4) carbonic acid, both the latter being dissolved in the liquid water.

Iron remains quite free from rust in an atmosphere containing oxygen, carbonic acid, and water vapour, so long as the water vapour does not condense as liquid water on the surface of the iron.

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*Paper read by Professor A. Crum Brown, before the Iron and Steel Institute, at Edinburgh.

Let us consider now the action on iron of the three substances—liquid water, oxygen, carbonic acid—singly, and then two and two.

Liquid water, quite free from dissolved gases, does not act on iron at ordinary temperatures. At high temperatures, very rapidly at a red heat, iron is oxidised by water or water vapour, and is converted into the magnetic oxide of iron. This magnetic oxide is formed on the surface of the iron as an adherent coating, and only when it is detached can the water gain access to lower layers of the iron.

Oxygen gas alone does not act at ordinary temperatures on iron. At high temperatures it also converts the iron into the magnetic oxide, which forms an adherent coating.

The same is the case with carbonic acid gas, acting alone. At ordinary temperatures it is without action. At high temperatures the carbonic acid is reduced to carbonic oxide, and the iron is oxidised to magnetic oxide, which forms an adherent coating.

Liquid water with oxygen dissolved in it does not act at ordinary temperatures on iron. This is shown by the fact that ordinary water, exposed to the air, does not rust iron if the water contains a substance, such as lime, or caustic alkali, capable of combining with carbonic acid and itself without action on iron. As long as the lime or caustic alkali is there, no rusting occurs. When the lime or caustic alkali has been converted by the carbonic acid of the air into carbonate, then, and not till then, can the carbonic acid of the air dissolve as such in the water, and then, and not till then, does rusting begin.

Water, containing carbonic acid dissolved in it, acts on iron at ordinary temperatures, forming ferrous carbonate, which dissolves in the carbonic acid water, forming, no doubt, ferrous bicarbonate. In this way artificial chalybeate water has been prepared by shaking up finely divided iron with carbonic acid water. In this action hydrogen gas is given off. Solutions have been thus prepared containing nearly one-tenth per cent of iron. If oxygen is present dissolved in the water, it will unite with the nascent hydrogen; and if we have sufficient water, iron, and carbonic acid, the whole of the dissolved oxygen will be thus consumed. The presence of dissolved oxygen quickens the solution of the iron, the tendency of the oxygen to combine with the nascent hydrogen supplying an additional motive to the action. Probably in ordinary rusting no hydrogen actually becomes free, as under ordinary conditions there will always be enough dissolved oxygen to convert all the nascent hydrogen into water.

When a solution of ferrous bicarbonate is exposed to an atmosphere containing neither free oxygen nor carbonic acid, it loses carbonic acid, and insoluble ferrous carbonate is precipitated. If free oxygen is present in the atmosphere to which it is exposed, the ferrous carbonate is oxidised to ferric hydrates, carbonic acid being given off. This, if the water is not already saturated with carbonic acid, dissolves in the water.

We can now follow the whole process of rusting, and divide it into stages—these stages being really separable, if we take proper precautions, but in the usual case overlapping one another.

We have, first, the formation of soluble ferrous bicarbonate; second, the conversion of ferrous bicarbonate into ferric hydrate, the white ferrous carbonate passing through green and black intermediate substances into the reddish-brown ferric hydrate, *i.e.*, rust.

We have to note that the carbonic acid dissolved in the liquid water, which is necessary for the process of rusting, is not used up in the process. It is given off during the oxidation of the ferrous bicarbonate to ferric hydrate, and is thus ready to act on the new surface of the metallic iron. The continuation of the process of rusting is not, therefore, dependent on new carbonic acid absorbed from the air, but the original carbonic acid, if not removed, can carry on the process indefinitely, as long as liquid water is present and oxygen is supplied from the air. Once the process is started, it goes on more rapidly, because the porous rust not only does not protect the iron, but favours, by its hygroscopic character, the condensation of water vapour from the air as liquid water. A piece of iron, therefore, which has begun to rust, will continue rusting in an atmosphere not saturated with water vapour, an atmosphere in which a piece of clean iron will not rust, because liquid water will condense from such an atmosphere on the hygroscopic rust, but not on the bright iron.

COMPRESSED FUEL.

Many attempts have been made from time to time to utilise coal dust as fuel. The most successful have been those which converted the dust, by the use of some kind of binding mixture, into a solid briquette for convenience of carriage and storage. For various reasons, but mainly owing to the cumbrous character of the plant and the cost of manufacture, this method of utilising coal dust has not made much headway. A new machine, however, for the manufacture of these briquettes has just been invented by Mr. Moull and Mr. Messenger, of Dover, which possesses several features of novelty, and overcomes most of the objections urged against its predecessors. The new machine is of comparatively small size, and the briquettes made by it measure only 4½in. long by 2½in. wide and 2½in. deep, and weigh 1¼lb. each. In making these briquettes the coal dust is first mixed with 10 per cent of crushed pitch, and the mixture is fed into a vertical mill, in which the ingredients are thoroughly incorporated by stirrers. At the bottom of the mill the ingredients encounter a jet of steam, which melts the pitch and brings the mixture into a plastic condition. The mixture is then fed into a revolving mould, and the charge receives its initial pressure from a horizontal plunger. The mould then makes a partial turn and the partially compressed charge encounters another plunger, which gives it the final pressure. Another partial turn brings the compressed charge to an ejector, which pushes it out of the mould into a trough, from which the briquettes are removed by a boy on to a tray, to be taken away for stacking. The briquettes are ready for use in about an hour from the time they have been delivered from the press. The action of the machine is continuous, the operations of moulding, pressing, and ejecting being carried on simultaneously by means of the rotary mould block. The rate of ordinary working is about 14 briquettes per minute, or five tons per day of 12 hours, which can be increased to six tons if necessary by working at a higher speed. The machine can be erected at a comparatively small cost, and can be worked by unskilled labour. It can be driven either by horse or steam power, so that its services are available where steam is not to be had. The result of the burning of this fuel in ordinary grates are said to be very satisfactory, a good bright fire being maintained without trouble and with but very little ash. The machine is being introduced by the Universal Patent Fuel Machine Company, of 32, Fenchurch Street, London.

THE ELECTRIC MOTOR IN MINING OPERATIONS.—II.

(Concluded from page 454.)

3. Hauling.

Under this head too much cannot be said, but I shall be brief. The application to street railways bears a strong resemblance to the hauling of ore; therefore, I will mention what has been accomplished in this direction. There are in the aggregate, in this country, about 125 miles of railways so operated to-day; the motors propelling loads of 10 tons, at speeds of 1 to 15 miles per hour, to distances of eight miles, and over grades of 10 per cent. Probably 2,000,000 passengers are now annually carried on these roads. As to size, let me mention that three years ago I had charge of the experiments then made on the Elevated Railroad of New York City. The weight of the motor was 9½ tons, and capacity about 100 H.P. With this motor the four regular coaches, nearly full of passengers, were drawn over a distance of two miles, and up grades of 2 per cent, at an average speed of eight miles per hour. I believe this is the largest experiment of its kind that has ever taken place in this country.

In the application to mining work, the principals involved are plainly the same, the change being only in detail. There have been already numerous applications abroad, and one in this country. The best known application to mining haulage was made in 1882, at the Zankerode pit, near Dresden, in Saxony. They employ there some 800 wagons, each of about 3 cubic feet capacity. The motors are of 6 H.P. capacity, and haul trains of from 10 to 20 wagons, maximum weight 13 tons, at a speed of about five miles per hour. The length of track is ⅓ mile. The cost of operation has been about 1½ cent per ton. The total cost of the plant was about $4,000.

An interesting comparison from actual practice shows the ratio of cost of operating to be as follows:

Electric Traction.	Horse.	Man.
2·7	3·7	6·2

Since the above tests were made, great improvements have been made in the efficiencies of motors; hence, although the above is an excellent showing, a still better one could be made to-day. The efficiencies to-day of good motors range from 85 to 95 per cent.

Dr. Hopkinson, an eminent English scientist, from very careful tests of the Ressbrook and Newry Railroad, found that its electrical efficiency was 72·7 per cent. From other sources we have proof that this figure is by no means excessive; and it is safe to say that a plant installed with ordinary care in any mine would give from 60 to 70 per cent electrical efficiency. I place the figures for mining work lower than in surface tramway work, since it is reasonable to suppose, from conditions commonly existing in mines, that not as excellent results could be obtained as from a surface road.

The only systems to be compared with the electric under this heading are those of the locomotive and the wire rope. In construction, the locomotive system requires nothing but the rails;

electricity, the addition of an overhead wire, easily placed, and requiring practically no attention; and the wire rope, a line of sheave-wheels, upon the floor of the level, upon which rests the rope, the whole squarely in the way of any other traffic in the same level. Furthermore, with wire ropes, the room required at the mouth of the level or incline for the gears, winding-drums, engine, &c.; the constant expense of repair and maintenance; the short life of the cable, its liability to breakage and consequent stoppage of the entire line; its inapplicability for crooked workings, and, lastly, its enormous waste of power (since there never is obtained in useful work overcoming resistance of traction and grades, over 25 or 30 per cent of the prime source of power)—all unite to render its adoption for mining work almost absurd in view of the simplicity and practicability of the electric system. Except for hoisting, there is practically no place for wire ropes in mining operations.

The steam engine worries with its complications and constant attendance; its heat; its smoke and gases, vitiating the air; and, lastly, its fire-setting ability. For haulage, the steam engine in mines is to be avoided. Through the adoption of the electric motor all these worriments disappear.

4.—Transporting.

Under this head I wish simply to mention the few recent developments relating to what is known as the telperage system. Wire ropes are stretched from post to post across country as desired; depending from these ropes are cars; the motor is placed in one of these cars, and drives up to the driving wheels by means of belts, chains, or gears.

Several different plans have been devised as to position of ropes and cars, but essentially they are all alike.

It is beyond all question that there is a very prolific field for application in this direction, and the stimulus necessary is the only thing now lacking for a general adoption in scores of places.

Abroad, the idea has been put into practical shape by those two eminent electricians, Professors Ayrton and Perry. The line at Glynde, England, is about one mile long, and used to transport clay. Trains of 8 or 10 skips are ordinarily made up, and when loaded the total weight is 2 tons. In every way it was most practically and thoroughly tested, and in every way it has given perfect satisfaction.

5.—Pumping.

This heading is, unquestionably, a most important one; and one which demands a great deal of careful consideration on the part of the mining engineer. For practical working, the only methods now employed to any considerable extent are those of direct-acting steam pumps and pumps operated from the surface through wooden beams.

Compressed air is too expensive, and there is no practical motor for driving the pumps.

Wire ropes are likewise expensive and inapplicable; and any hydraulic method is away out of the question. Steam, as mentioned above, is employed—but under what difficulties and expense? Consider the piping, the maintenance, and the excessive loss due to radiation. Furthermore, for any considerable distance steam is entirely impractical.

The practical application of the electric motor is simple, since most manufacturers of pumps adapt them for belts or gears. The only thing, then, to provide for is a belt or a pinion for the armature shaft. The intervening distance between the power station, on the surface, and the point where the pump is needed, is of small consideration as regards construction, for copper wires can be easily run irrespective of distance or conditions. A plant, complete, consisting of 30 H.P. dynamo, 20 H.P. motor, with wires, insulators, &c., would cost about 3,200 dols., and would be capable of doing—one mile distant from station—20 H.P. actual work in pumping water.

A number of applications have already been made abroad—notably at St. John's Colliery, Normantown, and at the Thallern Colliery, on the Danube. Another application is a small plant at the Trafalgar Colliery, England: here, the duty of the motor was to pump 114 gals. per minute through 3,900ft. of 7in. pipe, with a lift of 300ft. The motor capacity was 10 H.P.; the operating expenses, per day of 22 hours was 35 dols.; total cost of installation, 3,220 dols.; efficiency, 45 per cent—*i. e.*, of the belt power from engine to water thrown out, only 55 per cent was lost. The cost of such a plant to-day would be undoubtedly diminished one-half.

The wooden-beam method mentioned, working in connection with a plunger pump, has no claims to convenience or economy, and in these days is simply used in the capacity of a cheap makeshift. Consider the room it necessitates; consider the limited distance through which it can be operated; and, finally, consider its efficiency, and no one can think of it in comparison with electricity.

Taking all things into consideration, I would unhesitatingly agree to guarantee, outside of certain limits, two gallons pumped by electricity for every one now pumped by any other existing system for the same cost and expense of maintenance.

6.—Ventilating.

Upon this topic much can be said; but no particularly new application of electricity is called for. There are hundreds of large fans in daily operation throughout our country, and there is no reason why they cannot be used in mines; in point of fact, I consider it the only proper method whereby a mine can be ventilated. In large mines, especially in the coal regions, an enormous suction fan is placed at the mouth of the up-cast shaft, and the air is sucked through the entire system. Evidently where the men are working at the various headings, and in the stalls or rooms, the only way fresh air is obtained is through the construction of wooden boxes leading air in. This is extremely expensive, not only to construct but to maintain.

It seems to me that by the proper placing of numerous motors each attached to a fan of the well-known Wing or Blackman form, a constant circulation can be maintained.

By dividing a mine into sections, and then by placing in the partitions between each section electric fans, all propelling the air in the same direction, a perfect system is to be had. Plainly, fresh air must be drawn in somewhere and the foul air expelled at another shaft.

For ventilating chambers, a small motor can be placed at the entrance of each near the top, blowing the air out into the general level, along which the main body of air is propelled. In principle, it may be somewhat similar to the first plan I have just mentioned, but you overcome the tremendous frictional losses.

All previous general remarks as to convenience and simplicity that I have made upon the electric motor will apply here, and I will not repeat them. Certain it is that there is a great field for study and application in this direction. Abroad, several mines are already ventilated through the agency of electric motors.

7.—All Other Work.

It is unnecessary to say much under this head, for it seems to me that what has been said already sufficiently shows that the adaptability of the electric motor is universal. It is a positive fact that any mine in this country, with all its varied mechanical appliances, could be operated entirely by electric power; and I have no doubt that within a few years such a general application will have been made.

In concluding this general paper, I would indicate, as what seems to me to be the pith of the application of electricity to mining operations, the concentration of the entire production of power in one building; the facilities of distribution, irrespective of distance and difficulties, and the comprehensiveness of the applications of the same form of motive power.

CORRESPONDENCE.

We do not hold ourselves responsible for the opinions of our Correspondents.

HISTORY OF THE MARINE ENGINE.

To the Editor of "The Practical Engineer."

Sir,—In *The Practical Engineer* of Sep. 14th, I observed, in reading the "History of the Marine Engine," in the remarks on the triple-expansion type, that Dr. A. C. Kirk appears generally to be recognised as the originator of the improvement which has revolutionised the construction of the steam engine for marine purposes. I must admit that he has done a fair share in making it a commercial success, and establishing its superiority to that of the compound; yet, like all other builders of triple-expansion engines, he has followed a predecessor. In 1872, Mr. Peter Ferguson, manager to Messrs. Thos. Wingate and Co., engineers and shipbuilders, Partick, Glasgow, designed a triple-expansion engine with three cylinders of progressive capacities, having a three-throw crank shaft, with an initial pressure of 100lb. per square inch, and it is gratifying to think it is at present employed in the pilot service at Rangoon. Two years elapsed before Dr. Kirk designed his triple-expansion engines for the Propontis, and, to all appearance, on the same principles. Now, considering these remarks, I cannot understand how the name of Mr. Ferguson is not amongst the few worthy of special recognition, and who, I think, is deserving of the first place, being the pioneer in this most important development of the marine engine.—Yours, &c, A. McF.

Sep. 20th, 1888.

QUERIES AND REPLIES.

Flat Cast-iron Surfaces (Ribbed).—Any reliable data for calculating the bursting pressure of a flat cast-iron ribbed surface, such as a steam chest cover, or casing side, will be thankfully received by Orion.

Answer.—If the webs are made the same thickness as the plate, and their depth not less than two and a half times their thickness, then if

P = pitch of webs in inches
T = thickness of plate in sixteenths of an inch

Safe working pressure $= \frac{50T^2}{p^2}$ X. A. E.

Navy Electrician.—Could you or any of your numerous readers give me any information as to the requirements of electricians in the Navy, and how one who has a good knowledge, both practical and theoretical, of electric lighting may become one?—T. H.

Answer.—I can find no reference to these appointments in the Navy List. The best course for "T. H." would be to apply to the Secretary to the Admiralty, Whitehall, London, who would furnish him with any information he required.—X. A. E.

Artificer in the Navy.—Can any of your numerous readers afford me any information as to the steps required to become an artificer in the navy? Is it requisite to pass an examination? and is it necessary to enlist for any length of time? What is the rate of pay? If an examination has to be passed, what books is it desirable to study?—W. H. A.

Answer.—An engine-room artificer, according to the new classification, receives pay as follows: 1st class, £118 12s. 6d. per annum; 2nd, £109 10s; 3rd, £104 18s. 9d; 4th, £100 7s. 6d. To qualify for an artificer an examination has to be passed. This is of an easy character, but only certain trades are eligible. The engagement is for ten years. Full information with regard to the appointments can be obtained from the Secretary of the Admiralty, Whitehall, London.—X. A. E.

Answer.—If "Artificer" will send a stamped envelope to the Steam Reserve Office, Chatham, he can obtain a circular which will give him all the information he requires.—Marine.

Designing Winch Barrels.—Can any reader give me a formula for finding the breaking and also safe working strain for the barrel of a winch, first, when the barrel is a plain cylinder, and, secondly, when it is bellied inwards so as to have a less diameter at the middle than at the ends? Which will be the weakest point when a load is being lifted? I should be glad also to be shown—by diagram or otherwise—the strains which come upon the bearings.—Nimrod.

Answer.—In reply to "Nimrod," I may state that the weakest part of each of the two winch barrels named by him is through their transverse section at the middle port of their length, so that the formula that answers for one will apply to the other.

Let L = the length in inches between the middle of the bearings.
a = the distance in inches from the centre of one of the bearings to the point where the load is applied.
d = the diameter of the cylindrical one, and also the smallest diameter of the other in inches.

Then the breaking weight in lbs. $= \frac{4460\,d^3}{L}$ and not more than one-eighth of which ought at any time to be applied.

And the pressure of the load (W) on one of the bearings will be $\frac{a\,W}{L}$ and on the other bearing $\frac{(L-a)\,W}{L}$.—W. A.

Hydraulic Ram.—A cylinder 18in. diameter requires 65lb. pressure per square inch to force the piston rod which forms a hydraulic ram against a total resistance of 2,800lb, per square inch. What reduction must be made in the area of the ram if the steam pressure on the piston be reduced to 40lb., so that the hydraulic ram may still exert the same pressure?—John Laxey.

Answer.—The area of the ram will require to be reduced just in the same ratio as the steam pressure, that is, $\frac{65\text{lb.}}{40\text{lb.}} = \frac{\text{present area.}}{\text{reduced area.}}$

Therefore reduced area $= \frac{40}{65} = \frac{8}{13}$ of present area.—Ed.

Marine Engineer: Board of Trade Certificate.—Could you kindly inform me through your columns the qualifications and conditions required for a Board of Trade certificate for marine engineers, or where I can obtain such information?—Marine.

Answer.—Full information with regard to the Board of Trade examinations for marine engineers is given in the Memorandum Exn. 1a., published by the Board of Trade. The price is 6d. and it may be obtained either through any bookseller or purchased direct from Messrs. Eyre and Spottiswoode, East Harding Street, Fleet Street, London, E.C. Another useful memorandum (Exn. 1b.) is also published by the Board bearing on the matter, and contains many useful hints. The price is 1d., and it may be obtained in the same way. For information as to the best way of obtaining a situation as sea-going engineer, in the first instance, see answer to "Marine Engineer," in our issue for July 27th, page 359; also remarks under heading of "To Intending Marine Engineers," in our issue for March 9th, page 119.—Ed.

Book on Railway Switches and Crossings.—Can any reader of your practical and valuable paper inform me of the most modern edition on railway switches and crossings, with name of author, and cost?—W. L.

Answer.—There is a book published on the above subject, called "Tables of Switches and Crossings for the Australian Railway Gauge," by S. Pollitzer, C.E., Sydney. Published by Turner and Henderson.—Draughtsman.

Automatic Brake for Locomotive.—Will any reader tell me where I can find a sketch and description of an automatic brake for a locomotive?—Soyez Fume.

Helical Wheels.—Can any of my fellow-readers inform me of the best mode of setting out the teeth of a pair of bevel helical wheels, the larger wheel to be 34·8in. diameter, with 6in. face and 73 teeth, 1½in. pitch, and the smaller one or pinion 18·14in. diameter, with 6in. face and 38 teeth 1½in. pitch? Also a plain spur wheel 77·98in. diameter, with 140 teeth, 1¾in. pitch, to work in a pinion 40·1in. diameter, with 72 teeth. Any information with regard to making the patterns would oblige.—J. W. J.

Would some reader kindly inform me what is the proportionate strength of helical wheels in comparison with spur wheels having similar diameter, pitch, and face; also what is the rule for finding the breaking strength of helical wheels?—W. R. E.

Fixing of Propeller Shaft.—In further answer to the query which appeared in our issue of September 7th, with regard to the best method of fixing and retaining the propeller shaft, our readers will find on page 463 of this issue a detailed working drawing of the stern tube of a steamship with full explanatory description.

Hardening Steel.—Can any reader inform me if there is any book published on the hardening and tempering of steel, explaining the why and the wherefore? If so, what is the price, and by whom is it published?—Coot.

Square-threaded Screws.—Can any of your numerous readers give me any information with regard to square-threaded dies, and why they are not more generally used?—J. M. G.

Whitworth's Fluid Compressed Steel.—I should be glad of any information regarding the manufacture of this steel.—J. M. G.

Pressure on Spiral Springs.—In the answer which I gave "G. B." on the above, and which appeared on page 435, the last line but one from the bottom of the first column should read, "the modulus E required to be $\frac{16{,}000 \times 100}{125} = 12{,}800$ tons," &c.; this follows from the deflection in the case cited being 25 per cent in excess of that found when E was taken at 16,000 tons.—Orion.

Speed and Friction of Pumps.—I should feel greatly obliged if you would inform me what is the best working speed of bucket, plunger, and other pumps, in feet per minute, and what percentage extra they could be worked up to in case of an emergency (I suppose the depth of lift would affect the speed); also what is the friction of water in pump trees?—W. R. Evans.

Radiation.—What is the rule for finding the radiation of heat from a boiler, say working at 30lb. pressure, ½in. shell, with temperature of atmosphere at 65 deg., the boiler to be fixed vertically?—W. R. E.

Weighing Machines.—Is there any book published dealing specially with the construction of these machines, and what is the price?—T. D.

TO CORRESPONDENTS.

W. H. B.—We have received your letter of the 17th inst., and appreciate your kind remarks with regard to the value of our publication. In noticing any novelties, we endeavour, as far as possible, to judge the article entirely on its merits, without any regard to ulterior considerations, and the fact that we have no pecuniary interest in the plug we reviewed is, we think, pretty conclusive evidence on this point, and redounds to our credit rather than otherwise. Thanks for the circular you enclose; the plug therein illustrated appears to possess several points of novelty and interest.

M. F. B.—We hardly see how we can personally assist you in obtaining the information you ask. We have not access to the premises of the Cable Tramways Company, and do not know anything about their machinery. Your best course would be to write direct to the secretary of the company, who would probably furnish it, unless the company have some special reason for keeping it secret.

Felix.—We have received your further communication of the 21st instant, *re* Lift of Pump Clacks. You appear to misunderstand the question a little. What we say is that there is nothing gained by increasing the lift of a valve beyond one-fourth its diameter. It is quite true, as you say, that a lift of 1½in. with a 6in. valve would only afford an outlet of about 28 square inches as against 50 square inches, the area of the 8in. pipe. You appear to have overlooked the fact, however, that even if the lift were increased to 2¾in., so as to make the area of the valve outlet, measured circumferentially, equal to that of the 8in. pipe, the area of the valve, considered as the area of a circle, would still remain 28 square inches, and the fluid has to pass through this contracted area before it reaches the enlargement. Looking at it in another way, suppose you take the valve out of its seat altogether, the area of the outlet of the valve would, according to your method of reasoning, be infinite, whereas the area of the orifice could not exceed that of a 6in. circle. We trust that, with this illustration, we have made the point clear.

John Dunlop.—The time required for a body to fall 100 fathoms, or 600ft., may be readily determined from the formula—

$$t = \sqrt{\frac{2s}{g}}$$

Where t = time in seconds;
s = space in feet;
g = gravity 32.

Applying the formula and substituting the quantities, we have—

$$t = \sqrt{\frac{2 \times 600}{32}} = 6{\cdot}1 \text{ seconds.}$$

J. W.—The piston rod would move through a distance of 6·06 miles in an hour, and the rim of the flywheel through 9·5 miles.

R. R.—You could get a copy of the Weights and Measures Act from Messrs. Eyre and Spottiswoode, East Harding Street, Fleet Street, London, E.C. We don't know the price. A capital book on English Composition is one by Professor Nichols, published by Messrs. Longman, price 1s. We try to meet the wants and wishes of our readers as far as possible, but don't you think that in asking us to check through a number of arithmetical sums you are trespassing just a little too much on our good nature? The answers to the questions, as far as we understand them, are quite correct in principle, but we have not tested the actual arithmetic, and we are not quite sure whether we correctly understand No. 3, regarding scale for plan. Thanks for your remarks *re* ventilation. We think, however, the further answer given by "H" in last week's issue gives all the information necessary.

Anxious.—You are quite correct in your conclusion. A head of 22ft. would exert a pressure of about 9·6lb. per square inch.

Vulcan.—In the absence of a sketch showing the arrangement you describe, it is rather difficult to answer your question. If you will send us a sketch, we will try and answer you.

M. E.—On looking into the matter, we find that an error was made in the calculation, and that the engine in question under the conditions stated would be developing, as you say, 32 I.H.P. as nearly as may be, and have communicated with our correspondent to that effect. Thank you for pointing out the error. With regard to the query in the latter portion of your letter, this would take up too much of our time and space. In fact, to deal with it as fully as you wish would mean writing a special article. We hope shortly to deal with the subject of theoretical diagrams generally in a way which will probably enable you to solve the question for yourself.

MISCELLANEA.

The Sanitary Aspect of Electric Lighting.—In his address to the Mechanical Science Section of the British Association, Mr. Preece stated that in the Central Savings Bank, in London, it had been found, after two years' experience of electric lighting, that the average amount of absence from illness amongst those employed had been reduced by about two days per annum for each person.

A Machine for Preparing and Welding Pipe Joints.—Messrs. Woodhouse and Rawson, Limited, of 11, Queen Victoria Street, London, are introducing a machine for preparing and welding pipe joints recently patented by Mr. H. V. Hartz, of Cleveland, U.S. Both the male and female portions are made by the action of suitably shaped rollers, heavily pressed against the tube and rotating round it, causing the metal of the pipe to flow into a suitable shape, the action, in fact, being the same in principle as that of the ordinary tube expander.

Launch of a New Cruiser.—The Melpomene, a new protected cruiser with a displacement of about 3,000 tons, was launched from the Royal Dockyards, Portsmouth, on Thursday, the 20th inst. The vessel has been built with exemplary despatch for a Government establishment, as it is not quite twelve months since the vessel was first put on the stocks, and the heads of the Portsmouth yard deserve credit for the commendable promptitude they have displayed in the execution of the commission.

Railways in the United States.—From Mr. Poor's American Railway Manual, it appears that the length of new railway lines constructed in the United States in 1887, amounted to 13,080 miles, bringing the total open to traffic on the 31st December last to 149,912 miles. The amounts of share capital and funded debt on the total milage open was £838,312,406 of the former and £837,388,623 of the latter, converting the dollar at 4s. In addition there was unfunded debt to the amount of £58,936,414, and current liabilities amounting to £44,648,800, so that the total share capital and debt amounted to £1,779,286,243.

The Manchester Ship Canal.—The Great Docks at Eastham.—Rapid progress is being made with the first section of the Manchester Ship Canal in Cheshire, stretching from Eastham to Ellesmere Port, a distance of four miles. The great basin, which is to form the site of the locks at the Eastham terminus, has now assumed the appearance of a great ravine 200 yards in width, and it is estimated that one and a half million cubic yards of earth have been moved on this section. Preparations are now being made for commencing the building of the great lock gates, which, with the exception of those constructed for the new docks at Hull, will, it is said, be the largest in the world. The dock gates will be 80ft. wide in the clear. Three locks are to be constructed abreast of each other. The smallest will be 150ft. by 30ft., the next 350ft. by 50ft., and the largest 600ft. by 80ft.

The New Magazine Rifle.—The reports which are being prepared with reference to the behaviour of the new magazine rifle, a number of which had been issued to various infantry battalions for trial, state that the rifle stands exposure very well, but in many other respects the opinions expressed are not so favourable. In the hands of trained marksmen, old soldiers, indifferent shots, and recruits, it is said that the almost entire absence of recoil is greatly appreciated, and it is considered that much improvement in musketry should generally be the result. The increased velocity and low trajectory also contribute to the same result. Fault, however, is found by some with the mechanism for the extraction of the cartridge, and it is suggested that the hand-guard is not sufficient protection against heat in long-continued firing. In some cases the cartridges were found to jam when filling the magazine, while serious objection is raised to the delay experienced in replacing an exhausted magazine with a full one, and it is stated that ten rounds can be fired more rapidly from the Martini-Henry than from the magazine rifle, it being necessary to fix a second magazine in order to get off ten rounds.

A Novel Bridge.—A project has been set on foot at Amsterdam for the construction of a bridge which will be of somewhat unique design. Amsterdam is growing so rapidly that it is necessary to find further building space beyond that which is provided by the present limits of the city. There is an abundance of such space on the other side of the North Sea Canal, but this is of no avail unless some means can be adopted for keeping up direct communication with the city without affecting the traffic along the canal. An ordinary bridge would be out of the question, because it could not be constructed sufficiently high to allow ships to pass underneath; while to open the bridge every time a vessel wanted to pass would mean a serious interference with the traffic across the bridge itself. The project of Messrs. E. W. Shimmel and E. Haverkamp will avoid both these difficulties. They propose to construct on each side of the canal a gigantic tower, the two being connected by a bridge resting on their highest points, at a sufficient height to allow of ships of ordinary dimensions passing underneath. Around each tower there will be a winding gallery, which, making three complete circles, will give a gradual ascent from the roadway to the elevated bridge across the canal. This "spiral" will be sufficiently solid and sufficiently wide to allow two vehicles to pass one another at any point; and it is also proposed that the ordinary tramcars shall mount to the bridge, and cross over to the other side by this novel means without any necessity for the passengers leaving the cars. Provision will be made for turning round the connecting bridge on a central pivot by hydraulic power in case any vessel of unusual height should want to pass along the canal.

SELECTED PATENTS.

APPLICATIONS FOR LETTERS PATENT.

September 14th.

13279 Carriage Axle Oil Cups, J. A. Wilson, Dundee.
13284 Regulating Feed Water, G. S. Fleming, Glasgow.
13295 Metal Springs, A. Nicholls, G. R. Bunnett, and E. C. Fâche, Middlesex.
13299 Improved Yarn, A. C. Lössel and E. Farrar, London.
13305 Wood-planing Machines, A. J. Boult, Middlesex. (P. Dominguez, Spain.)
13307 Type, W. P. Thompson, Liverpool. (P. A. Duprez, France.)
13317 Trans-shipping Coal, S. W. Allen, J. Platt, and J. Fielding, Middlesex.

September 15th.

13319 Self-acting Machine for Sawing Timber, A. Greg, of the firm of J. Chadwick and Brothers, London.
13320 Tram-car Pneumatic Locomotives, W. P. O'Neill, Longford.
13323 Refrigerators, L. White, Manchester.
13326 Sinking Metal Cylinders, J. Hawthorne, Newcastle-on-Tyne.
13330 Striker Ruling Machines, J. Shaw, Honley.
13334 Hydraulic Ship Cranes, J. Fielding, Gloucester.
13340 Heating Iron and Steel, W. H. Willatt, Hull.
13341 Gas Batteries, P. Scharf, London.—[Complete Specification.]
13347 Grinding Twist Drills, J. H. Storey and H. J. Bamford, London.
13349 Steam Boilers, H. Gourlay, London.
13351 Looms, A. J. Boult, Middlesex. (O. Reiz, Germany.)
13356 Engine Pistons, E. Doubtfire, G. Webster, and A. Jackson, trading as the firm of Webster, Jackson, and Co., London.
13357 Tapering or Reducing Iron Tubes, W. Pilkington, London.
13359 Extraction of Copper, H. Doetsch, London.

September 17th.

13364 Purified Water, J. E. Slack, London.
13374 Steam Boilers, T. Blanford, Corbridge-on-Tyne.
13380 Automatic Gate, J. T. Pickering and E. W. Sant, Stockton-on-Tees.
13381 Power Loom, J. Campbell, Dundee.
13383 Expanding and Non-compressive Apparatus, J. E. L. Ogden, Yorkshire.
13388 Feeding Water, J. Murrie, Glasgow.
13404 Relief Valves, C. T. Brown, London.—[Complete Specification.]
13405 Double Blast Bellows, W. Baxter and J. Baxter, London.
13410 Driving Pulleys, R. Hornsteiner, London.—[Complete Specification.]
13411 Driving Gear, R. Hornsteiner, London.—[Complete Specification.]
13414 Gas Motors, A. J. Boult, Middlesex.
13423 Sandblast Apparatus, R. N. Coldwell, Islington, and J. Davis, New Barnet.
13425 Gas Engines, W. von Oechelhaeuser, London.
13427 Steps, C. Pilgrim, London.

September 18th.

13434 Cleaning Apparatus, J. S. Roake, London.—[Complete Specification.]
13442 Governor, F. Smith, Manchester.
13443 Gauge, H. Dalgety, Surrey.
13450 Pistons, E. Davies, London.
13454 Dust Excluder, H. J. Morriss, London.
13455 Wrought-iron, A. E. Alexander, London. (L. D. Chapin, United States.) [Complete Specification.]
13457 Rotary Engines, J. C. Robertson, London.—[Complete Specification.]
13466 Metallic Piston Packing Rings, J. D. Churchill, London.
13468 Couplings, J. Clarridge, sen., and J. B. Pickard, London.—[Complete Specification.]
13471 Hydraulic Rivetting and Punching Machines, W. Arrol, of the firm of W. Arrol and Co., Glasgow.
13479 Screws and Nuts, A. G. Dawson and F. E. Adams, London.
13484 Hoisting Blocks, W. P. Thompson, Liverpool. (A. M. Kerr, United States.)—[Complete Specification.]
13486 Steam Engines, H. H. Lake, London. (E. G. Shortt, United States.)
13495 Shuttles, H. Weissenburger, J. Elsas, and P. L. Kobertz, London.

September 19th.

13499 Gasholdes, F. C. Suggate, Crewe.
13502 Seamless or Weldless Tubes, J. Hudson, Birmingham.
13506 Feed-water Heaters and Condensers, C. A. Knight, Glasgow.—[Complete Specification.]
13516 Forming Sand Cores, J. Frankland and W. H. Summerscales, Halifax.
13519 Electric Motor, F. Teague, London.
13529 Electric Meters, A. Reckenzaun, London.—[Complete Specification.]
13547 Tanning Hides and Skins, J. Y. Betts, London.
13550 Taps or Valves, E. T. Lambert and E. J. White, London.
13553 Affixable Table for Draughtsmen, F. Wenzel and W. Croncmeyer, London.

September 20th.

13557 Pumps, J. S. Warburton, Essex.
13560 Water Gauge Fittings, J. A. Rowe, North Shields.
13569 Looms, E. Hodder and O. Bullock, Salford.
13579 Self-guiding Gasholders, A. Stokes, London.
13582 Pressure Reducing Valve, E. Lones and B. A. Webb, London.
13586 Valves and Valve Gear, T. W. Baker, N.
13589 Hydraulic Lifts, C. L. Jackson and J. Blackburn, W.C.
13593 Hydraulic Engines, E. J. Miller, London.
13598 Electric Motors, R. R. Hutchinson, London.
13601 Steam Boilers, H. Gourlay, London.
13603. Digging Machine, P. A. Newton, Middlesex. (P. J. Larsen, Denmark.)—[Complete Specification.]
13611 Vacuum Apparatus, J. B. Alliott and H. S. Firman, London.
13612 One-cylinder Compound Engines, E. Davies, London.
13616 Cut-off Valve, J. M. Bell, London.
13620 Furnaces for Smelting Silver, &c., R. Parkinson, London. (Partly communicated by J. Moffatt, North Queensland.)

PUBLISHERS' ANNOUNCEMENTS.

BACK NUMBERS of "The Practical Engineer," from the commencement, can be obtained at either of our offices in London or Manchester, or by order of any Newsagent.

Vol. I. (bound), containing Nos. 1 to 44 inclusive, from March to December, 1887, price 6s. 6d., can still be obtained by order from any Newsagent, or will be forwarded, carriage paid, from either of our offices on receipt of the amount by postal order or stamps.

Numerous complaints having been made to us by Subscribers of the difficulty they experience in obtaining copies of the *Practical Engineer* in certain districts, we have to state that the Journal can be obtained by any Newsagent through the ordinary trade channels, and no difficulty should therefore exist in obtaining copies by order of any Newsagent.

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&c., &c., &c.

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EDITORIAL NOTICES.

All communications for the Editor of this Journal should be addressed to 6, Victoria Station Approach, Manchester.

Communications intended for insertion in the current week's issue should reach us not later than Tuesday Evening.

We cannot undertake to return rejected manuscripts or drawings unless accompanied by a stamped and directed envelope.

Contributors are requested to write on one side only of the paper. Sketches should be sent on separate sheets.

TO ADVERTISERS.

Advertisements intended for insertion in the current issue should reach us on Wednesday morning at the latest.

THE
PRACTICAL ENGINEER.

OCTOBER 5TH, 1888.

THE CIVIL SERVICE COMMISSION.

THE report of the Royal Commission appointed to inquire into the working of the various offices of State at home and abroad, which has just been issued, will be calculated to cause a flutter of excitement in the Civil Service dovecote. It states that the bulk of the work in all Government offices can be satisfactorily performed by clerks who have received an ordinary commercial education, but that there are departments in which men of a higher culture are required to fill the more important posts, and further, that the requirement of such men is greater in some offices than in others. In the Revenue Department, for instance, the Commissioners are of opinion that all the supervision and higher work can be done by men admitted under the lower examinations.

The Commissioners, while of opinion that entrance to the service should be controlled by examination as at present, state that subsequent promotion should be determined by merit alone, and not by the present routine system of promotion by seniority, which they characterise as the "great evil of the service." It is, they say, desirable to proceed throughout on the principle of always selecting the fittest man, instead of, as at present, considering merely the claims of seniority, and rejecting only the unfit.

It is recommended that the salary of the lower division clerks should commence at £70 per annum and gradually rise to £350, while that of the upper division should begin at £200 and range to £500.

The first year's service, it is urged, should in all cases be regarded as strictly probationary; and if it be found at the end of that time that the candidate does not possess the elements necessary for making an efficient servant, there should be no hesitation in discharging him.

In order to secure promotion by merit, it is recommended that the total possible rise and salary should be divided into several classes, and that promotion from one class to another should only be effected on condition that a satisfactory report with regard to the diligence and character of the clerk is received from the head of the division in which he is engaged.

The Commissioners state they desire to emphasise the recommendation that no servant should be advanced into a superior grade unless he has shown himself thoroughly competent to perform work of a superior character, and that if a young man who has entered the public service cannot show proof of this, there is no possible reason why he should receive higher pay.

The report advises that the age for retirement from the service should be raised from sixty to sixty-five, with the understanding that a man may be required to retire at sixty should the head of his department consider it necessary.

Referring to the question of hours of work, the report recommends that in all cases the length of the working day should be seven hours, and that the regulations with regard to holidays and sick leave should be the same throughout the service.

The report also deals at considerable length with the vexed questions of pensions and superannuation. From an appendix thereto it appears that during the current financial year the pensions payable amount altogether to upwards of two and a quarter million pounds. Of this sum upwards of one and a half million comes under the cognisance of the Commissioners, who state that the list has been swollen in a variety of ways of which they strongly disapprove. In some cases incompetent men have been pensioned prematurely in order to get rid of them; in other cases ill-health has been admitted as a reason for retirement, without sufficient proof that it has been sufficiently grave to warrant the plea; while in numerous other cases pensions have been granted simply because the special service on which the official was engaged has been no longer called for. It thus happens that a number of thoroughly competent men in the prime of life have become transformed into unemployed pensioners, instead of being transferred, as they ought to have been, to some new department of work.

It can hardly, we think, be denied that many of the facts revealed in the report constitute serious defects—not to use a stronger word—in our Civil Service system. The work of the Commission appears to have been executed with a desire to thoroughly expose abuses and root out defects, and we trust the Government will see its way to carry out the recommendations made in the report. Their adoption would, we think, be productive of benefit not only to the public at large but also to the service itself.

THE ASSOCIATED CHAMBERS OF COMMERCE.

The Chambers of Commerce which exist in most of the leading centres of manufacturing industry are so representative of the wealth and influence existing in commercial circles that the proceedings at the periodical meetings of the Associated Chambers become invested with special importance, and call for more than passing notice, reflecting as they do the opinion of leading commercial men regarding the various current or prospective legislative proposals that crop up from time to time in connection with commercial affairs.

The autumn meeting of the Association has this year been held at Cardiff, and the proceedings, which lasted for several days, have dealt with a wide range of subjects. The first question discussed was that of technical education, and a resolution was passed thanking the Government for their Bill dealing with the matter, while it was unanimously recommended that provision should be made for giving direct assistance to technical schools established by voluntary contributions. A motion by Mr. Waite, of Leicester, for empowering school boards to give technical instruction to their scholars at whatever stage they might think fit was rejected by a small majority.

Referring to the question of private bill legislation it was to be expected that the Association would unhesitatingly condemn the present costly and cumbrous method of procedure, and unanimously recommend the adoption of some more simple and economical method. As they point out, at present it not unfrequently happens that clients are at present compelled to pay twice over for establishing their case before two separate committees, and, however advantageous this course may be to the lawyers, it hardly commends itself to the common sense of business men.

The question of railway charges and the desirability of using canals as competitors with railways for inland traffic, was one on which the meeting was fairly agreed, and the recent Railway and Canal Traffic Act was unanimously approved.

The desirability of an increase in the naval strength of the country in order to afford adequate protection to commercial interests was approved by a large majority; though, as was to be expected with a question of this kind, having a slight political bearing, protests were uttered by several dissentients.

The extension of the Trade Marks Act to India and the Colonies was discussed at length, and unanimously voted to be desirable. The motion of Mr. Maclean, of the Oldham Chamber of Commerce, however, advocating the adoption of an Indian Factory Act, on the lines of the one regulating the home industry, was not successful in obtaining the requisite two-thirds majority of votes.

The decimal system of coinage and weights and measures was also a subject which came up for discussion, and the Association pronounced favourably upon it.

The advisability of a reduction in the rental of telephones and its more general adoption by the post office were also matters upon which there was a pretty general agreement.

The business of the conference was concluded with votes of thanks to the Foreign Secretary for the issue of commercial reports, and also to the President and Council of the Association for calling special meetings for the discussion of Bills in Parliament affecting commercial interests.

A RAILWAY HERO.

The records of industrial enterprise are replete with acts of heroism, and noble deeds of daring and self-sacrifice are performed every day in the workshop and the mine of which the outer world never hears a word. It is only perhaps when some act of self-abnegation results in the forfeiture of the hero's life that the attention of the public is drawn to the deeds of daring and bravery that are daily performed amongst its army of grimy workers, and it is realised that fearless devotion to duty may be found in the workshop as well as on the battlefield.

The death of Anthony Thompson, a locomotive engine-driver, a few days ago in the Bradford Infirmary, serves to remind all who travel by rail what it is they occasionally owe to those in charge of the train. About a week ago, while a train was running from Bradford to Leeds, the back-draught caused a flash of flame to suddenly rush out of the firehole door in front of the engine, with the result that Thompson, the driver, and Robert Hicks, the stoker, were both shockingly scorched by the fiery blast. Notwithstanding the terrible nature of their injuries, however, the men bravely stuck to their posts and brought the train safely into Leeds. Thompson's fearless devotion has, as we have seen, cost him his life, while his mate, the stoker, is still incapacitated from work. Railways are not usually supposed to supply themes for poetry, but such self-denying heroism reminds us instinctively of the story of the pilot of the burning Mississippi steamer, who stuck to his post and sacrificed his life in order to save the vessel's living freight; and in future the name of Mainyard, the pilot, will in our minds be indelibly associated with that of Thompson, the locomotive driver.

DISASTROUS BOILER EXPLOSION AT BIRMINGHAM.

A disastrous boiler explosion occurred on Saturday morning last at the Flour Mill of Messrs. Watson, Todd, and Watson, Vincent Street, Birmingham, resulting in the loss of four lives and serious injury to several others.

The boiler which was the cause of the explosion was one of a group of four, and is stated to have been of the Cornish type. Up to the time of going to press we had not been able to glean much information with regard to the cause of the explosion. It appears, however, to have been of an extremely violent character, and judging from the extensive destruction of property which resulted, it would appear very probable that the boiler has failed in the external shell. Whether, however, the failure of the boiler has been due to its defective condition, or whether the pressure has from some reason or other been allowed to accumulate until it became dangerously excessive, we cannot say. These points will no doubt be fully inquired into by the coroner, as well as by the Board of Trade, who have ordered a preliminary inquiry to be made into the cause of the disaster.

The Ohio Gas Springs.—According to Dr. Ernest Weisenbauer, professor of geology in the University of Heidelberg, the inhabitants of the districts in Ohio, where the natural gas springs exist, are in imminent danger of being blown into eternity. The learned doctor is of opinion that at a considerable depth below the surface there is an immense cave filled with gas, which might easily explode, and that below this again is a glowing furnace of subterranean heat which is slowly eating its way to the gas cave, and that the impending disaster cannot be long deferred. It may be some comfort to the inhabitants of the district in question to know that American geologists do not accept the professor's theory or share his fears.

STRENGTH OF FURNACE TUBES.

The following is a copy of a communication referring to the strength of furnace tubes to resist collapse, which has been addressed to our contemporary, *Engineering*, by Mr. D. K. Clark. Having regard to the eminence of the writer in the engineering profession and the importance of the subject to a many of our readers, we offer no apology for its reproduction.

Referring to the desirability expressed for a "good all-round rule" for application to all such structures, Mr. Clark states that in his opinion it is quite time to abandon the ordinary formulæ which involve the length of the furnace tube as a factor, as this has practically nothing to do with the resistance to collapse, except where the length is reduced to a few feet, when the longitudinal tensional resistance becomes of some use as a support. Mr. Clark then goes on to remark as follows :—

When the tube springs or incipiently collapses, the collapsing part, no doubt, is subject to tensional stress by the fact of its deflection from a straight line between the extremities. Conceive a longitudinal strip of the flue, 1in. wide, to be isolated and suspended between the ends, and subjected to uniform pressure. The line of argument adopted by me for calculating the strength of flat end plates is applicable here.* The ultimate elastic deflection is

$$\delta = \frac{l}{44} \quad (1)$$

in which δ = the deflection at the mid-length, and l = the length of the strip, or, in this case, that of the flue. Conceiving the strip to take approximately the form of a segment of a circle, the diameter d of the circle = 11·18 l, and the elastic stress in the strip strained to the elastic limit, is

$$p = \frac{4480\ ts}{11{\cdot}18 l} = \frac{400{\cdot}7\ ts}{l} \quad (2)$$

p = the pressure of steam in pounds per square inch.
t = the thickness of plate in inches.
s = the tensile stress in the plate, in tons per square inch, at the elastic limit.
l = the length of the strip in inches.

Substituting the values of s, 12 tons and 14 tons for iron and steel respectively, the formula becomes

$$p = \frac{400{\cdot}7 \times t \times 12}{l \times 12}$$

for iron ; and, reducing, it becomes for iron and steel, dropping fractions,

for iron, $$p = \frac{400\,t}{l} \quad (3)$$

for steel, $$p = \frac{470\,t}{l} \quad (4)$$

in which l = the length in feet.

The resistance to collapse is directly as the square of the thickness of the plate, and inversely as the square of the diameter. The first ratio is obviously true ; and for the second, whilst the leverage of the pressure to double up the plate increases as the diameter of the flue, the pressure also increases as the diameter ; and the stress is in the combined ratio of leverage and pressure, or as the square of the diameter.

To form an idea of the assistance derivable from longitudinal tension in resisting collapse, take an instance of an iron flue tube 25ft. long, 36in. in diameter, of ⅜in. plate. By formula (1) the ultimate elastic deflection of a flat strip under the given circumstances is

$$\delta = \frac{l\,\text{ft.} \times 12}{44} = \frac{300}{4} = 7\tfrac{1}{2}\text{in.}$$

and the pressure by which such deflection would be produced is

$$p = \frac{400 \times \frac{3}{8}}{25} = 6\text{lb. per square inch.}$$

A deflection of 7½in. is inadmissible for useful resistance, and allowing even 1in. of deflection, within working limits, the corresponding pressure would not exceed 1lb. per square inch.

Take, again, a segment of a flue of ⅜in. plate, made with flanged joints, 3ft. in length, the deflection of a 1in. strip, within the elastic limit, would be

$$\frac{l \times 12}{44} = \frac{3 \times 12}{44} = 0{\cdot}82\text{in} ;$$

and the acting pressure would be

$$\frac{400 \times \frac{3}{8}}{3} = 50\text{lb. per square inch.}$$

But, unfortunately, the co-operation of longitudinal resistance can only be brought into action by such a deviation from the cylindrical form as seriously to impair or even to destroy the direct compressive resistance to collapse. Thus, in the case of considerable lengths of flue tubes, the longitudinal resistance, except within very narrow limits, is not available as a security against collapse. Let us assume the arbitrary limit of deflection or deviation from the normal form of 1in. for the exertion of longitudinal tensional resistance. The following are the relative pressures per square inch that would be supported and resisted under that condition, for various lengths of plain iron flue tubes :

TABLE I.

Length of Tube.	Deflection.	Pressure per Square Inch resisted by Longitudinal Tension for several thicknesses of Plate.		
		⅜in.	$\frac{1}{16}$in.	½in.
ft.	in.	lb.	lb.	lb.
3	·82	50	58	67
6	1·00	15	17·5	20
9	1·00	7	8	9
12	1·00	4	4·75	5
15	1·00	2·5	3	3·5
18	1·00	1·7	2	2·2
21	1·00	1·2	1·5	1·6
24	1·00	1	1·2	1·3

From this statement it appears that the longitudinal resistance to collapse of plain flue tubes, though important for short lengths of from 3ft. to 6ft. or 9ft., is insignificant for greater lengths ; and that, therefore, all the resistance to collapse of unfortified lengths of plain flue tubes more than 9ft. or 10ft. long, is supplied substantially by the compressive strength and the stiffness of the tube.

The following instances of collapsed flues of Cornish and of Lancashire steam boilers are collected from the reports of the Chief Engineer of the Manchester Steam Users' Association. They comprise flue tubes of from 32in. to 48in. in diameter, ⅜in. and $\frac{7}{16}$in. in thickness, and from 18ft. to 40ft. in length. The working pressure of steam at or about the time when each collapse took place is given in the fourth column of the table, and the compressive stress on the metal, per square inch of section, is given in the last column. This stress is not generally so much as 1 ton per square inch. In some instances, no doubt, the flue tubes had been sensibly worn ; but in most instances they had been in good order.

TABLE II.—COLLAPSED FURNACE TUBES OF CORNISH AND LANCASHIRE STEAM BOILERS—UNFORTIFIED PLAIN TUBES.

Length of Tube.	Inside Diameter of Furnace Tube.	Thickness of Tube.	Working Pressure of Steam in Pounds per Square Inch.	Stress per Square Inch of Longitudinal Section of Tubes.
1.	2.	3.	4.	5.
ft.	in.	in.	lb.	tons.
18	32	⅜	60	1·16
24	34	⅜	68	1·40
25	35	⅜	64	1·35
26	35	⅜	60	1·28
43	36	⅜	50	·82
28	36	⅜	45	·74
33¼	39	⅜	45	·80
25¼	41	⅜	40	·74
28	42	⅜	45	·86
30¼	42	⅜	45	·86
32	44	⅜	40	·80
34	48	⅜	40	·87
17	34	$\frac{7}{16}$	55	·87
32	43	$\frac{7}{16}$	57	1·12
40	45	$\frac{7}{16}$	45	·92
32	47	$\frac{7}{16}$	50	1·07
30	48	$\frac{7}{16}$	43	·94
33	48	$\frac{7}{16}$	42	·92
32	48	$\frac{7}{16}$	50	1·10
28	48	16	50	1·10

It is plain from this table that the mere length of flue tube did not influence the quantity of the resistance, which was simply the direct resistance to collapse. Plotting the pressures on ⅜in. plate tubes, column 4, as ordinates to a base line representing diameters, column 2, the medium curve traced through the plottings shows that the resistance to collapse varied inversely as the 1·75 power of the diameter, that is to say, not in so great a ratio as the square of the diameter. It shows that :

For diameters of.....................30, 35, 40, 45, 50in. ⅜in. plate
The collapsing pressures were 76, 58, 45, 37, 30lb. per sq. in.

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*See paper by D. K. Clark on the "Strength of Flat Plates and Segmental Ends of Boilers and other Cylinders," in the Minutes of Proceedings of the Institution of Civil Engineers," vol. liii., page 170.

The collapsing pressures for plain iron flue tubes, $\frac{3}{8}$in. thick, are represented by the expression

$$\frac{5000}{d^{1.75}}\text{lb. per square inch} \quad (5)$$

Plotting likewise the result for plain tubes made of $\frac{7}{16}$in. plate, though limited in range, they show that:

For diameters of.............. 40, 45, 50in. $\frac{7}{16}$ plate
The collapsing pressures were 60, 49, 42lb. per sq. in.
Against the pressures......... 45, 37, 30 „ „ for $\frac{3}{8}$in. plate.

These resisting pressures are relatively as the squares of the thicknesses of plate, and the numerator of the expression (5) is convertible into the value 36,000 t^2, giving for the general equation of the resistance of plain iron furnace tubes to collapse,

Collapsing Pressure of Plain Iron Flue Tubes of Cornish and Lancashire Steam Boilers.

$$p = \frac{36,000\ t^2}{d^{\,1.75}} \quad (6)$$

p = collapsing pressure in pounds per square inch.
t = thickness of the plates of the furnace tubes, in parts of an inch.
d = the internal diameter of the flue tubes in inches.

NOTE.—This formula expresses the collapsing resistance of plain iron furnace tubes of any length not less than 9ft. or 10ft.

For shorter lengths it has already been shown to what extent the longitudinal tensile resistance may be effective in augmenting the resistance to collapse. It would follow that flues efficiently fortified by flange joints or hoops at intervals of 3ft. may be enabled to resist from 50lb. to 60lb. pressure per square inch more than plain tubes.

NEW LOCOMOTIVE WORKS FOR THE LONDON AND SOUTH-WESTERN RAILWAY.

OWING to the increase of traffic and the corresponding demand for rolling stock, the locomotive, carriage, and waggon works of the London and South-Western Railway Company, at Nine Elms, which were originally designed by the late Mr. Joseph Beattie, have been recently altered and enlarged under the supervision of Mr. William Adams, the present locomotive superintendent.

The works, which now cover 45 acres of ground, and give employment to upwards of 2,000 men, were visited a few days ago by the members and associates of the Society of Engineers.

The visitors were first shown the locomotive department, where the various details of the locomotives and tenders are prepared and finally erected into the complete engine and tender. There is first a machine shop, 164ft. long by 57ft. wide, well fitted with the most modern machine tools, among which milling machines are conspicuous. The cylinder shop is 57ft. long and 29ft. wide, and the cylinders can be bored out two at a time. The fitting shop is 118ft. long by 58ft. wide, and is arranged upon the most approved plan.

Among noteworthy locomotive details seen was the "vortex" blast pipe, which is the invention of Mr. Adams, and its application to the locomotives of the South-Western Company for the past three years has, it is stated, resulted in a large saving in coal. The average consumption of fuel, which in 1885 was 30lb. per engine mile, has been by its aid reduced to 26½lb. per mile, and the total saving in coal bills since June, 1885, is, it is said, nearly £34,000. There are now 300 engines on this railway fitted with the "vortex" blast, which is giving satisfaction in every respect.

The brassfitters' shop is 59ft. long by 45ft. wide. In this is made, besides the brasswork in general, the white metal piston and valve rod packing which is used in all the new South-Western locomotives. The millwrights' shop is 85ft. long by 58ft. wide, and in it are made the small machines used in the Nine Elms shops generally.

Passing by the coppersmiths' shop, the visitors entered the large machine shop, which is 300ft. long by 57ft. wide. All the machines in this shop are placed in groups with reference to their respective classes. The wheel shop is 195ft. long by 57ft. wide, and contains some very fine wheel lathes, travelling cranes, wheel studding, and other machines, as well as a tire furnace and a shrinking well.

The erecting shops consist of two bays, each 500ft. long by 57ft. wide, and which afford accommodation for 70 locomotives. Power is supplied to the small tools in this shop through hydraulic mains at a pressure of 1,500lb. per square inch.

The tender shop is 90ft. long by 51ft. wide, and the boiler shop 178ft. long by 116ft. wide, divided into two bays.

Next in succession come the boiler-mounting shop, the hydraulic engine house, the boiler house for supplying steam to the fixed engines on the works, the smiths' shop, the forge, the foundry, and various other departments, all of which are of large size and are well appointed.

The carriage building shop and the saw mill are next reached, after which come the carriage machine shop, the running shed, and other departments connected with carriage and waggon building. All these are upon the same extensive scale as the locomotive shops, of which we have given the leading dimensions.

The works altogether are very comprehensive, and are most complete in every respect, reflecting great credit on Mr. Adams as regards design, execution, and management.

It may be observed in conclusion that the South-Western Railway Company has now in operation about 850 miles of line, which is served by 550 locomotives, 3,000 carriages, and 8,000 waggons.

AN ENGINEER'S LIFE AT SEA.—XV.

BY A SEA-GOING ENGINEER.

(Continued from page 452.)

THE relation between the chief engineer and the captain is this: Each is supreme in his own department, but between them is a narrow neutral zone, over which a domineering captain sometimes seeks to claim control. No engineer worthy of the name will submit to this, for such encroachment, once tolerated, soon becomes unbearable. As when disagreements among the three engineers arise, the blame may usually and fairly be laid upon the chief, so when he and the captain are at loggerheads the captain must usually be held responsible. The one desire of a sensible chief is to be let alone, but this does not always suit a captain who desires to magnify his office, and who feels himself effaced when everything is running smoothly. Remembering with regret the old and absolute rule of the shipmaster, when none dared to oppose him on his own domain, he seeks to keep in their proper place the black squad of mechanics who come to divide authority with him. As "a whole is greater than its part," and a ship larger than the engines within it, so is a captain greater than a chief. The one keeps in activity throbbing life within, the other directs the course of the encompassing framework. Though a captain can suspend or supersede an offending engineer by another, while the attention cannot be made reciprocal, yet a mate can, in certain cases, supersede the captain himself. Such arrangements are only made for convenience, and each one is directly and individually responsible to the Board of Trade, which exacts a strict account, and which would as readily dismiss an engineer who should plead the captain's orders as an excuse for wrongdoing, as it would dismiss, and so ruin, a captain for tyrannical interference with an engineer. The pay of a captain exceeds that of an engineer, but, as plausibly urged by the latter, this is no measure of intrinsic worth. The number of mates with a captain's certificate is largely in excess of the number of "seconds" holding a higher certificate, and in consequence, competition would soon bring down a captain's pay if it were not for the desire of shipowners that it should exceed that of the engineer, which by itself has a higher marketable value.

Among engineers themselves want of harmony is not uncommon. Sometimes with reason, but more frequently without it, a "chief" will dislike a "second," or a "second" despise a "chief." In this latter case the "second" and "third" usually combine against the common foe, but if the "chief" be a man of determination and energy, he has by far the best of it, in virtue of the power given by his position. A "third," new to the sea, should be careful how he listens to the representations of the "second," if the latter should try to persuade him that the "chief" is taking advantage of his inexperience to "put upon" him in the way of work. It may or may not be true. If untrue, patience and willingness to oblige are his best policy. If it be true, the same line of action will either disarm the aggressor, or cause the unfair impositions to become greater with a rapidity proportioned to his willingness to oblige, till there can be no mistaking them, and he will have to take action in self-defence. With men who thus seek to impose upon others, in order to display their authority or to lighten their own burdens, it is not always easy to deal. If one is too yielding and peace-loving, advantage is taken of it, and the quarrel which finally ensues is more violent than if he had taken a firmer stand at the beginning. Thus it frequently happens that the most peaceably disposed find that they have to cultivate a certain amount of bad temper if they are to avoid rows, which do not in every case end in words only. An engineer of any sensitiveness will require also a rare combination of qualities to steer through some of the unpleasantnesses of sea life. One thing he can do, if nothing else. No matter what his relations may be with those above him, he should determine that to those under him he will be invariably kind and considerate. *Then* the matter is largely in his own hands, and he may be forbearing to them in a way that he could not be to his "chief" without losing his own self-respect. In the same way, when he is a chief, though he may have harmony all through his own department, he may at the same time be in open and determined hostility to the captain. In a word, quarrel at discretion with your superiors, but never with your inferiors.

Besides unfair imposition of work, either open or covert, many other causes lead to strife. Foremost among these is the use of the counter. As this registers the revolutions made on each watch, rivalry at once springs up, and a laudable promptitude in relieving watch, the relief being on the platform at the stroke of the bell, so as to lose none of the revolutions. It also leads to attention to keeping steam, and may be necessary in mail boats, but rarely elsewhere. The firemen are bullied, and the engineers dispute as fiercely over a couple of revolutions as nations do over equally weighty matters. Then, ingenious devices are resorted to, so as to "take" the counter, and meditations upon this interesting subject help to while away many solitary watches. The quiet hours of night will naturally be found the best time for experimenting with some matured plan.

In one steamer, a counter stood at the top of the engine-room, within good view of the deck. This having been out of order for a long time, a new chief overhauled it, and put it in good working order. To his surprise, he found that a deep interest was being manifested in these proceedings by the mates, and that this lively solicitude could only be appeased by the issue of frequent bulletins, as with a royal patient. This acted like an inspiration, and the chief at once found, to his great regret, that without some indispensable part not specified, but only to be got ashore, the counter could not be made to work. That necessary part lacking was, it so happened, never supplied.

In some steamers, the starting and stopping of the engines is done with a small auxiliary engine, which throws the links over from ahead to astern and back again, by allowing it to continue its revolution. In a steamer so fitted, the main engine was partially linked up while at work, and it had also a counter. A self-confident "third," desirous of increasing his revolutions, hit upon the simple plan of "opening up" the engines on his watch, contrary to orders. He selected the hour after midnight for his dark design, but had not reckoned on the difficulty of controlling the starting engine. The "chief," being awakened by an unusual noise, rushed down the ladder, and found the main engines busy stopping, reversing, stopping, and going ahead again, and in ceaseless repetition of these proceedings, with the "third" vainly struggling with the handles in a desperate effort to master the demon he had summoned to his aid.

Again, in some ships the oil given out for lubrication is a measured quantity, and any excess used has to be accounted for. In one steamer where the allowance of oil had been foolishly reduced by the chief to the bare limit of safety, any engineer who had an easy watch would conceal some of the oil he had saved, for use on a watch which should prove troublesome. The principal aim of each then was to find where the others had hidden their stores, not in order to steal all their oil, for that would stop the supply, and kill the golden-egged goose, but to extract enough to increase his own store, a little at a time, without alarming the others. Experience teaches that it is best in such a case as the above to effect a bold robbery in port of a considerable amount, getting to the right side of the storekeeper if other means fail. This locking up of oil is more usual in steamers with four engineers than in smaller ones with three. With three engineers, the chief, by himself keeping a watch, has a more accurate knowledge of what is really required than when he rules from the clouds, like Olympian Jove.

Where engineers develop thieving propensities, they cannot expect the firemen to be immaculate, and, as a matter of fact, they are far otherwise. A fireman's great object in life is to pilfer as much waste as he can for unknown purposes, and at the same time to extract soft soap from the stores to wash his clothes. When cleaning the sooty side of boilers in port, a reasonable engineer will give soft soap for this purpose to the men engaged. But self-help, though good in itself, must in this case be discouraged. One "second" mixed caustic soda with the soap, but rather cruelly kept his own counsel, with the result that the next clothes washed and hung out to dry on the "fo'k'sle" head were perforated with holes burned in them. Should an engineer put in caustic soda, he should make it a point of honour to tell the men, as firemen are poor, and their crime is venial.

RHEEA FIBRE.

Numerous attempts have been made at various times to utilise the fibre of the rheea plant for purposes of textile manufacture, but hitherto with only indifferent success. Twice during the last eighteen years the Indian Government have offered a prize of £5,000 for a machine which should effectually produce the fibre in the required condition. The prize has been twice competed for and twice withdrawn. Recently the French Government have taken up the matter, and offered prizes of the value of 6,000 francs for any process or machine that will produce the fibre in commercial quantities and of proper quality, and the trials we believe are now being carried out in Paris.

The great strength, length of staple, and lustre which the fibre of the rheea plant possesses, are qualities which eminently recommend it for use in textile industries. The great difficulty in the treatment of the fibre up to the present, however, has been the elimination of the gummy matter in which the fibre is embedded. It has been found comparatively easy to decorticate the rheea stems—that is, to remove the fibre, with its adhering bark and cementitious matter, from the wood, but difficult to produce the fibres clean and free from all extraneous adherent matter, ready for the spinner, on a commercial scale. This holds good with all the varieties of this fibre, whether they be known under the name of China grass, rheea, or ramie—rheea being the Indian and ramie the Malay name of the same plant.

The solution of this important difficulty has lately been taken up by Mr. John Orr Wallace, of Belfast, who has approached it from a mechanical point of view, and the machine with which he hopes to solve the problem is to be seen in operation in the Irish Exhibition at Olympia.

The machine in question is a flax scutching machine of novel design, and about 6ft. 6in. high by 4ft. wide, and 5ft. long over all; its working capacity being put at 1cwt. of retted flax per hour. It consists of an upper feed table on which the flax-straw is fed to three pairs of fluted rollers, which deliver the flax downwards between five pairs of pinning tools, alternating with six pairs of guide rollers. The pinning tools somewhat resemble hand-hackles, and may be popularly described as very coarse wire brushes. They are attached to two vertical frames, to which a horizontal to and fro motion is imparted, and the pins interlace as the two sides approach. The fibrous material is drawn downwards by the rollers, which have an intermittent motion, and at each momentary pause the pricking pins enter the material and are rapidly withdrawn from it. By degrees this fibrous descending curtain is delivered on to a sloping receiving table at the bottom of the machine, over which table the woody substance has previously passed to a receiver in a crushed and semi-pulverised condition and perfectly free from fibre.

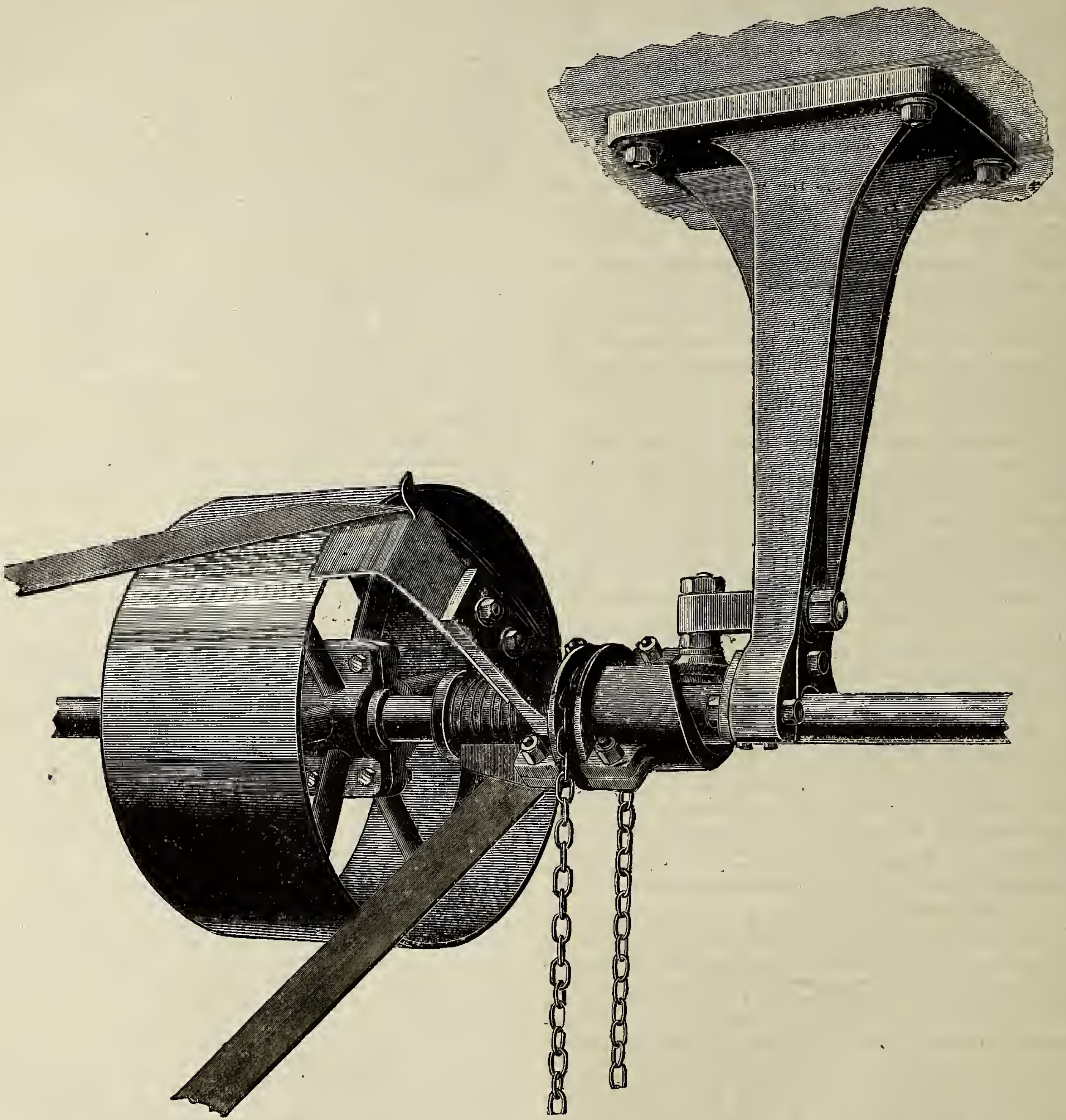
The machine, which is of simple construction, is the first full-sized one Mr. Wallace has had constructed, and, owing to hasty manufacture, some allowance has to be made in respect of want of finish. But inasmuch as it does its work perfectly as regards flax, the principle would appear to be correct. It is, moreover, to be borne in mind that the machine was not designed to treat rheea, but flax. Hence in some of its details it is imperfect as regards rheea.

Nevertheless, some stems of rheea which were put through were treated with excellent results as far as the mechanical separation of the fibre from the bark and wood is concerned. The stems were those of rheea grown at Kew, and were about 6ft. high, and of fair size. They had been retted for four days and were not quite dry. Mr. Wallace holds that they should be retted for eight days and completely dried. However this may be, the stems which were put through the machine were quickly done, and the fibre produced was fairly free from wood. Mr. Wallace states that he has yet to carry out a series of experiments with the view of ascertaining the stage at which the machine can be used with the best advantage to the fibre, and for this purpose it is intended to send to India a machine specially made for dealing with rheea.

The first point settled—that is, the proper stage at which the machine shall be used—Mr. Wallace is confident of being able to produce the fibre from his machine ready for use by the spinner, just as is already done with flax. It is to be hoped that he will succeed in effecting his object, which will be the means of giving to the textile industry a fibre which has been pronounced to be the strongest in nature, and for which the trade has been long and anxiously looking.

Professor Carnelly, of University College, Dundee, has been appointed professor of chemistry in Aberdeen University. He was educated at Owens College.

SHAW'S PATENT APPLIANCE FOR PUTTING BELTS ON PULLEYS.



THE operation of putting a rapidly-running belt on to a large driving pulley as ordinarily practised in mills and workshops is one involving no small amount of risk, as the numerous serious and fatal accidents that occur from time to time conclusively prove. Only those who know how readily clothing becomes entangled with a rapidly-running belt can fully realise the danger incurred by those whose duty renders it necessary to perform the operation, and how easily a life may be exacted as a penalty for a slight act of carelessness or oversight.

The illustration given above represents a simple and ingenious mechanical device for putting belts on to pulleys, which has been recently brought out by Messrs. T. and R. Lees, of Hollinwood, near Manchester. It entirely obviates the risk and danger involved in the present method, with its use of ropes, ladders, and other fixings, and enables the operation to be effected in a few seconds by one man with ease and certainty.

The device, as will be seen from the engraving, consists of a sleeve fitting loosely on to the shaft at one side of the pulley and cut obliquely at one end. The sleeve is fitted with a chain pulley, so that it can be made to revolve on the shaft by a person standing on the floor and actuating the chains depending therefrom. Standing out at right angles to the sleeve, and revolving with it, is a light bracket which is bent at the end and equal to the radius of the pulley. At the left-hand side of the sleeve, and bearing against a collar, is a spiral spring, which forces the sleeve to the right and causes its oblique end to bear constantly against the little bowl shown attached to a stud fixed into the hanger bracket. It will thus be seen that by working the chain and causing the sleeve to revolve, it is forced alternately towards or from the pulley. As shown in the engraving, the right-hand chain is supposed to be pulled downwards and the strap about to be delivered on to the top of the pulley. The further revolution of the sleeve, causing the strap and thin bent end of the carrier to revolve round the circumference of the drum for a quarter of a revolution, when the action of the sleeve on the bowl causes the carrier to be drawn back free of the pulley and turned through another half revolution, at which point it remains at rest until its services are again required. The action of the appliance is in fact very similar to that which is adopted when a strap is delivered on to a small pulley by the back of the hand with the thumb bent at right angles to the four fingers, and is, indeed, jus as easily and readily performed.

NEW TORPEDO BOATS.

The recent naval manœuvres of the British Fleet were of considerable interest in respect to the extent to which they were enabled to define the part which torpedo boats will probably play in future naval warfare.

It was clearly shown that the type of boat at present constructed, and known as "first-class," is seaworthy and safe in bad weather, though the wear and tear upon the crew, when at sea for a lengthened period, resulted in an amount of physical discomfort which, taken in conjunction with the limited supply of coal and water, renders it doubtful whether it is desirable to employ boats of this class to accompany an attacking fleet at a considerable distance from the base of supplies, especially as the movements of the large vessels are occasionally somewhat hampered by the necessity of protecting the torpedo boats themselves.

With the type of boat which is designated as "second-class," and which is designed for being hoisted bodily on to the deck of the vessel to which it is attached, the case is, of course, entirely different.

For assisting a defending force, however, the manner in which the "first-class" acquitted themselves proved them to be of the utmost utility, and there is no doubt that their behaviour during the recent manœuvres has caused them to rise greatly in the estimation of naval authorities.

The new first-class boats to be built by Messrs. Yarrow and Co., of Poplar, are to be 130ft. in length by 13ft. 6in. beam, and are to be constructed on what is known as the No. 79 type. In the official trial of this type a speed of 22·4 knots was obtained with the boat, fully equipped and in accordance with the Admiralty conditions, during a continuous run of two hours. Her turning power enabled a complete circle, either to port or starboard, to be made at full speed within one minute.

This result was not secured by any complicated system of steering, but by means of one rudder only, placed at the stern in the usual position. This exceptional power of manœuvring is due mainly to the absence, as far as practicable, of the deadwood at the stern, thereby reducing the side resistance offered by it to the action of the rudder. This principle was adopted in some Yarrow torpedo boats built for the Chilian Government in 1879, and of late it has been extensively and successfully introduced by Mr. J. Samuel White, of Cowes, in craft of smaller dimensions.

It has been found that the reduction of the deadwood not only secures a gain in steering, but, by reducing the area of the hull in contact with the water and the consequent surface friction, and owing also to the reduction in weight, a small gain in speed is also secured.

Another special feature in these new boats, and one of great importance to fighting ships, is the adoption of Yarrow's system of enclosing the furnace or firebox of the boiler in a complete water-tight casing. In this system all the air which is required for the purposes of combustion has to pass over the top of the casing, and then downwards to the furnace. The effect of this is to prevent the extinction of the fire should a sudden inrush of water find its way into the stokehold or boiler compartment. The importance of securing immunity from this untoward result will be self-evident when the probability of damage to the thin steel plates of the hull through shot or collision is borne in mind. The success of this arrangement is not problematical, the system having been practically tested and its efficiency fully demonstrated. It has been found that, although the boiler space may be flooded, and the boiler, in fact, completely immersed, as it were, in water, the boat still retains its steaming capabilities to an extent that will enable it to run from 40 to 50 miles.

The new boats will also be improved in respect of the arrangements for their armament. It will be remembered that the torpedo boats built two years since were fitted with five torpedo-launching tubes. Experience, however, has shown that this is too heavy an armament for boats of this size, so much so that it was found necessary to remove a portion of it from some of them.

In the new boats three launching tubes only will be carried, one being fitted at the bow and two near the stern, the latter being mounted for firing over the sides at angles capable of variation at the discretion of the officer in command.

The bow gun is for direct ahead attack, while the two guns for side fire are arranged for discharging their torpedoes when running at full speed past the enemy's ship. The consequence is that, in whatever position the boat may find herself in relation to the enemy, an attack can be made.

Throughout all the boats the torpedoes will be ejected by means of gunpowder impulse, which is completely superseding in Her Majesty's service the old and complicated system of compressed air.

In addition to the torpedo armament, the new boats will carry several machine guns and a powerful electric light on the conning tower. They will also be provided with means of distilling water should the supply run short.

Enclosed within the small compass of a hull, only a trifle more than the eighth of an inch in thickness, there will be no fewer than eight independent engines, including the propelling machinery, which will develop about 1,100 H.P.

The boats will have an estimated speed, fully equipped, of 22½ knots, and will be capable of turning within a circle the diameter of which will be equal to twice the length of the boat, while the coal-bunker capacity is to be sufficient to insure a radius of action of 2,000 miles.

LESSONS IN MECHANICAL DRAWING.—XXII.

By Prof. A. MacLay, B.Sc., C.E.

EXERCISES ON GEOMETRICAL LOCI AND POINT PATHS (*continued*).

PARABOLIC.

Ex. 117.—A line is 2in. from the centre of a circle of 1in. radius. Draw the curve, every point of which is equidistant from the line and from the circumference. The arc to be continued till it meets the diameter parallel to the line. (1868.)

Ex. 118, Fig. 122.—One end of a cord is attached to a fixed point F on a line OX, and the other to a point Q on the edge of the blade of a T-square. Suppose the head to be made to slide along the line YY^1 at right angles to OX, show the curve described when a pencil P keeps the cord tight against the blade of the square as it slides from Y to O, and (with blade reversed) from O to Y^1.

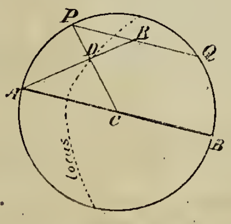


Fig 126

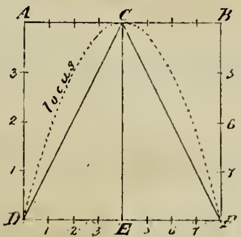


Fig 127

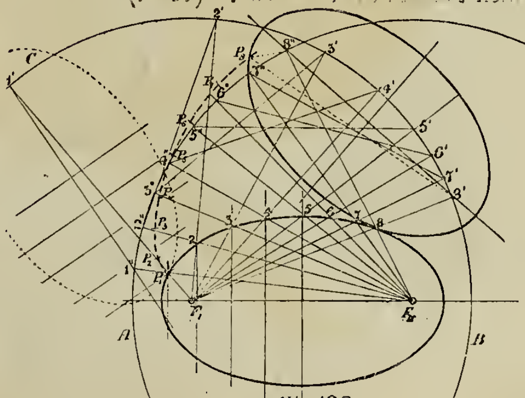


Fig 128

When a straight edge is laid along YY^1, and lead weights placed upon it, this forms a practical method sometimes adopted of drawing a parabola. Since $FP + PQ^1 = FQ$, by the conditions given, the position of the pencil P, corresponding to any assumed length of cord taken up, *e.g.*, PQ^1, can be readily found by laying off $QP^1 = Q^1P$ along QF, and with FP^1 as distance and radius, drawing a parallel to YY^1 and an arc, from F as centre, to intersect the parallel at P and P_1.

Ex. 119, Fig. 126.—Draw a circle, and let ACB be a fixed diameter of it. From any point P on the circumference draw a chord PQ parallel to ACB. Show the locus of the intersection of lines PC and AR, C being the centre of the circle and R the middle point of the chord PQ.

Ex. 120.—In Morin's apparatus for the experimental determination of the laws of falling bodies, a card is wrapped round a vertical cylinder. While the cylinder turns at a uniform rate, a pencil attached to a falling weight traces out a line on the card. When the card is removed and flattened out, it is found that the vertical lengths described are in the ratio of the squares of the horizontal ones. Show the curve traced by the pencil, supposing the unit horizontal and vertical distances to be $\frac{1}{4}$in. and $\frac{1}{20}$in. respectively.

On a horizontal OX mark off distances at 1, 2, 3, &c., units from O and on OY^2 (drawn downwards from OX); mark off distances at $1^2=1$; $2^2=4$; $3^2=9$, &c., units from O. Lines drawn to intersect, as in fig. 72, Lesson XIII., will give points through which to draw the path.

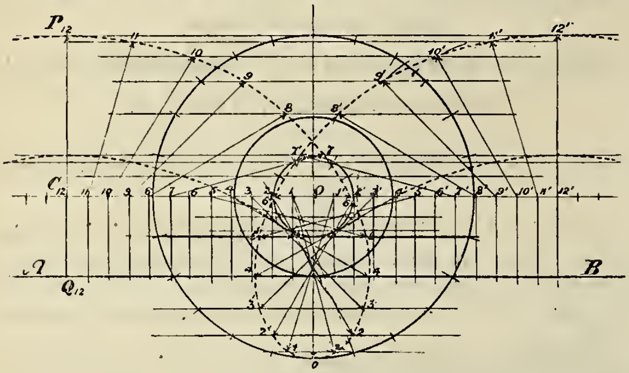


Fig 129

Ex. 121, Fig. 127.—A bar through AB turns round C as a centre, passing from position CD through AB to position CF in the same time that a second bar CE moves uniformly from AD to BF. The bar AB turns so that its intersection with DA and BF moves uniformly from D to A and from B to F.

Draw the path of the intersection of AB and CE.

The construction involved is one of the methods of describing the parabola.

HYPERBOLIC.

Ex. 122.—Describe a circle enclosing and touching three other circles of 0·6in., 0·8in., and 1in. radius respectively, each of which touches the other two. (1882.)

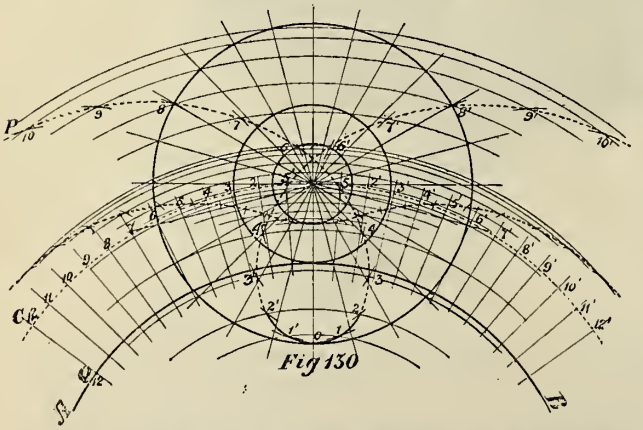


Fig 130

Ex. 123, Fig. 112.—"The locus of the centres of the circles, which touch two given unequal circles, is a hyperbola." Circumscribe the three given circles in fig. 112 by a circle. (1878.)

Ex. 124.—A and B are two fixed points 2·5in. apart. Draw the curve, every point of which fulfils the condition AP – BP = ·75in., P being a point on the curve. (1876.)

The ·75in. is the constant difference △ of Ex. 86, fig. 95.

Ex. 125, Fig. 116.—C is a cotton reel, which can turn about its vertical axis *a*. A and B are fixed pins. Two threads are led from the reel round the pins AB, as shown. The ends of these threads meet in a pencil P. Supposing that the threads always remain tight, draw the curve traced by P. What is this curve? (1880.)

The path of P will be the locus of centres of circles passing through the fixed point A, and touching a circle with centre B, radius PB – PA. For since in any given interval of time the same length will be added to both PA and PB, it follows that the difference of the distances PB and PA will continue the same throughout for any point P on the curve. The curve is therefore a hyperbola, of which A and B are the foci (see Ex. 86, fig. 95, page 307).

Ex. 126, Fig. 123.—A straight edge CA is arranged to turn about a fixed centre C at one end. A cord is attached to its other extremity A, and to a fixed point F. Trace the curve drawn by a pencil which keeps the cord tight against the straight edge, while the latter moves through the angle ACA_1.

This is a practical method sometimes adopted of drawing the hyperbola. A_1F represents the string fully stretched out. Any arc PQ, drawn concentric with AA_1, at a given distance $A^1P = A_1Q$ from it, will intersect an arc of radius $FQ^1 = A_1F - A_1Q$ described about centre F, at P and P^1, two points on the curve.

CYCLOIDAL.

Ex. 127.—A circle of 2in. diameter rolls upon a straight line. Draw the curve traced in one revolution by a point on the circumference of the circle. (1877.)

Ex. 128.—Draw the epicycloid obtained when the rolling circle is equal to the base circle, diameter 2in.

This particular case of the epicycloid gives the curve known as the "Cardioid," so called from its resemblance to the shape of a heart.

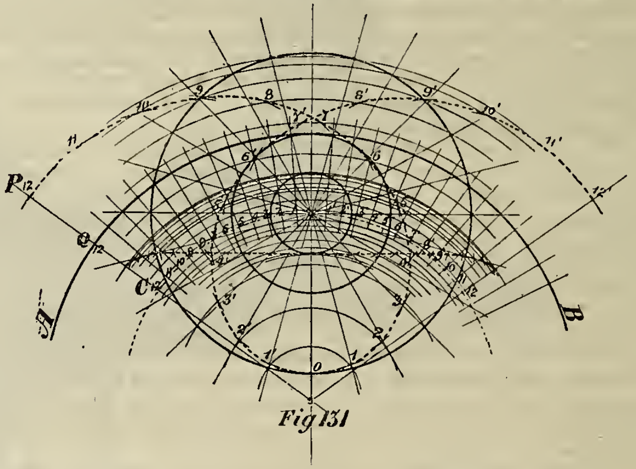


Fig 131

Ex. 129.—Draw the hypocycloid produced when the "directing" circle is of 1·75in. radius, and the "generating" circle is of ·58in. radius. (1873.)

In fig. 108 (page 367 ante) AQ_5B is an arc of the "directing" circle, and 7, 10, 7, 4 is the "generating" or rolling circle.

Ex. 130, Fig. 125.—Show by construction that when the diameter of a rolling circle is equal to the radius of its directing circle, the hypocycloid becomes a straight line (*e.g.*, *ab* of fig. 125).

Ex. 131, Fig. 125.—Cut the diameter of any directing circle into two unequal parts. Draw a describing circle on each part as diameter. Show by construction the coincidence of the hypocycloids derived from both of the latter (*e.g.*, *ef* in Fig. 125).

Ex. 132, Fig. 128.—Draw two equal ellipses in contact. Suppose the one to be fixed and the other to roll upon it; tracc the path of a point on the latter. Take the same dimensions as in Ex. 116.

Having drawn the lower ellipse (fig. 128), foci F_1 and F_{11} by any of the methods previously described; take any point P_1 on its periphery as the first point of contact. Through P_1 draw $F_1 1^1$ and $F_{11} 1^{11}$, making $P_1 1^1 = P_1 F_{11}$ and $P_1 1^{11} = P_1 F_1$. 1^1 and 1^{11} will be the foci of a second ellipse in contact with the first at P_1. Make a copy of the ellipse first drawn, with points 1^1 and 1^{11} in the place of F_1 and F_{11}. The simplest way is to draw ordinates (*i.e.*, lines at right angles) to a line passing through F_1 and F_{11}, and ditto in the same positions on a line through 1^1 1^{11}, as shown through the points 1, 2, 3, &c. With centres F_1 and F_{11}, radii $F_1 1^1$ and $F_{11} 1^{11}$ respectively, describe circles. These will be the paths of the foci of the rolling ellipse.

What we have to find now is the path of P_1 considered as a fixed point on the second ellipse while it rolls on the first. While the points

1^1, 1^{11} pass through the successive positions 2^1, 2^{11}—3^1, 3^{11}, &c., and the point of contact moves forward through 2, 3, &c., P_1 passes through P_2, P_3, &c. We may either assume successive positions of the point of contact, and draw lines through them from F_1 and F_{11} to find the corresponding positions of the foci on the circles AD, BC, or we may assume successive positions of one focus on the one circle AD, and find the corresponding positions of the other focus on the circle BC, since the distance between them is always equal to F_1, F_{11}, lines drawn from these to F_1 and F_{11} intersect at the points of contact.

Lastly, to obtain any point on the path of P_1, *e.g.* P_3, from 3^{11} and 3^1 as centres, radii $1^{11}P_1$ and 1^1P_1 respectively, draw arcs intersecting at P_3.

TROCHOIDAL.

Ex. 133 to 138.—Three thin discs of radii ½in., 1in., and 2in. are set concentrically and fastened to one another. Trace the paths of a point on the circumference of the outer and inner discs, while the middle one rolls—

(*a*) upon a straight line ;
(*b*) upon a circle ;
(*c*) under a circle.

The constructions are shown in figs. 129, 130, and 131. They are very similar to those of Ex. 94, figs. 107 and 108, with this modification, that the rolling circle is not also, in the present cases, the describing circle. The points of contact between the rolling circle and the guiding line or circle are measured off as before. The successive positions of the centres of the describing circles are, of course, the same as those of the rolling circle, but the parallels to the guiding line or circle are drawn through points on the circumference of the inner and outer circles, not through points on the rolling circle. In figs. 129, 130, and 131 the centres and the corresponding position of the tracing points are marked with the same number. The three curves *a*, *b*, and *c* are known as the *trochoid*, *epitrochoid*, and *hypotrochoid* respectively, the path described by the outer point being further distinguished as the *superior* or *curtate*, and that of the inner point as the *inferior* or *prolate* curve in each case.

Ex. 139.—Draw the curve generated by a point on the surface of a disc and ⅜in. from its edge, while the disc rolls along a straight line. Diameter of disc, 2·5in. (1870.)

Ex. 140.—A circle of 1in. diameter rolls on a plane. Trace the curve made by a point attached to it, and 1in. distant from its centre. What is the name given to this curve? (1881.)

Ex. 141.—Show by construction that the hypotrochoid becomes an ellipse when the diameter of the rolling circle is half that of the directing circle.

Ex. 142.—Draw the epitrochoid when the diameter of the rolling circle is equal to that of the directing circle.

This particular case of the epitrochoid gives the curve known as the Limaçon, referred to in the next lesson.

MISTAKES IN DESIGNING BOILERS.

One of the greatest mistakes that can be made in designing boilers, and the one that is most frequently made of any, consists in putting in a grate too large for the heating surface of the boiler, so that with a proper rate of combustion of the fuel an undue proportion of the heat developed passes off through the chimney, the heating surface of the boiler being insufficient to permit its transmission to the water. This mistake has been so long and so universally made, and boiler-owners have so often had to run slow fires under their boilers to save themselves from bankruptcy, that it has given rise to the saying, "Slow combustion is necessary for economy." This saying is considered an axiom, and regarded with great veneration by many, when the fact is, if the truth must be told, it has been brought about by the wastefulness entailed by boiler plants proportioned badly by ignorant boiler-makers and ignorant engineers, who ought to know better, but don't.

Let us consider the matter briefly: Suppose we are running the boiler at a pressure of 80lb. per square inch. The temperature of the steam and water inside will be about 325° F. The temperature of the fire in the furnace will under ordinary conditions be about 2,500° F. Now, it should be clear to the dullest comprehension that we can transmit to the water in the boiler only that heat due to the difference between the temperature in the furnace and that in the boiler. In case of the above figures, about seven-eighths of the total heat of combustion is all that could by any possibility be utilised, and this would require that radiation of heat from every source should be absolutely prevented, and that the gases should leave the boiler at the exact temperature of the steam inside, or 325°.

To express the matter plainly, we may say that the utilisation of the effect of a *fall* of temperature of 2,175° is all that is possible.

Now, suppose, as one will actually find to be the case in many cases if he investigates carefully, that the gases leave the flues of another steam boiler at a temperature between 500° and 600°. The latter temperature will be found quite common, as it is considered to give "good draft." This is quite true, especially as far as the "draft" on the owner's pocket-book is concerned, for he cannot possibly utilise under these conditions more than 2,500° – 500° = 2,000° of that inevitable difference of temperature to which he is confined, or four-fifths of the total, instead of the seven-eighths, as shown above, where the boiler was running just right, and any attempt to reduce the temperature of the escaping gases by means of slower "combustion," as he would probably be advised to do by nine out of ten men, would simply reduce the temperature of the fire in his furnace, and the economical result would be about the same. His grate is too large to burn coal to the best possible advantage, and his best remedy is to reduce its size and keep his fire as hot as he can.

This is not speculation, as some may be inclined to think. Direct experiments have been made to settle the question. The grate under a certain boiler was tried at different sizes, with the following result :—

With grate 6ft. long, ratio of grate to heating surface was 1 to 24·4.

With grate 4ft. long, ratio of grate to heating surface was 0 to 36·6.

The use of the smaller grate gave, with different fuels and all the various methods of firing, an average economy of 9 per cent above the larger one, and when compared by burning the same amount of coal per hour on each, 12 per cent greater rapidity of evaporation and economy were obtained with the smaller grate.—*Locomotive.*

20-TON ELECTRIC TRAVELLING CRANE.*

One of the travelling cranes in the foundry of the Erith Ironworks was originally constructed to be worked by hand, but preparations had been made to apply wire-rope driving at some future time.

The crane is 39ft. 6in. span, and consists of a pair of wrought-iron girders resting on end carriages running on an elevated line of rails. The gearing for hoisting longitudinal and for cross traverse is secured on to the top of the main girders; the hoisting chain passes from the barrel at one end over a pulley at the other, then back to the pulleys in the cross traversing carriage, which runs between the main girders, through a falling block, and thence to an anchorage under the barrel at the extreme end of the main girders. By this arrangement the crane occupies a moderate height, and the hook can come within 3ft. of each wall.

The inconveniences and wear attending the employment of rope-driving gear induced the writer to try whether electricity might not be used with advantage. Messrs. Elwell Parker, of Wolverhampton, were communicated with, and these gentlemen undertook to supply the dynamo and a motor suitable for the peculiar requirements of a heavy crane. The dynamo, which was intended to give 50 ampères at 120 volts, with 1,200 revolutions, was fixed in the main boiler-house of the works, and was driven by a small horizontal engine by means of a link belt. The leads from the boiler-house up to the conductor in the foundry are of 6 B.W.G. conductor wire, while the conductor is formed of an angle-iron bar, 2in. by 2in. by ¼in., extending the whole 350ft. length of the shop, and has one face roughly ground and protected from rust by vaseline. The return current travels along one of the rails on which the crane runs. The motor, which is shunt wound, and constructed for 100 volts and 50 ampères, is fixed on the working platform of the crane, beside one of the main girders. Its driving spindle carries a steel pinion which gears into a double helical spur wheel, keyed on to a shaft which runs longitudinally on the top of the girder, and is connected by nests of three bevel wheels, with friction clutch connections to the three shafts which command the several movements of the crane, the means of using the hand-power being still retained.

Two sets of speeds are arranged for each of the movements, namely: Hoisting, slow 3·4ft. per minute, fast 10ft. per minute; cross traverse, slow 25ft. per minute, fast 105ft. per minute; Longitudinal traverse, slow 78ft. per minute, fast 213ft. per minute.

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* Paper by W. Anderson, M.Inst.C.E., read before Section G of the British Association.

To provide against undue strains upon the motor an automatic magnetic cut-out is fixed on the crane, and for the purpose of varying the power and speed to meet the requirements of the foundry, a set of resistance coils is provided, governed by a special switch by means of which different resistances can be introduced into the armature circuit of the motor, or the current can be cut off altogether, but so that it must be done by steps, and not suddenly. The connection between the motor and the conductors is by means of brushes pressed against them by elastic attachments. The handles for operating the several movements, the break lever, the switch, and the automatic cut-out, are all collected together, so that a single attendant can readily work the crane from one spot.

The crane was set to work in June last, and has continued to act satisfactorily ever since. The advantages are very great in the facility of adaptation, as it is so easy to transmit the power from any point. The main boilers being always under steam, the crane is available at a moment's notice. The duty realised is about 65 per cent of the power developed in the driving steam engine. As far as can be judged at present there is no special wear to apprehend. The conductors act satisfactorily, though a considerable length is in the open air, and the dust, heat, and smoke of the foundry do not appear to affect the working.

When first proposed, the writer was not aware of the existence of any other electric crane, but he has since learned that Messrs. Mather and Platt, of Manchester, have had one working satisfactorily for some time, and that there is one also in France.

QUERIES AND REPLIES.

Pitch of Propeller.—Will "Omicron" please assist me in the following: How can I find the pitch of a detachable propeller blade before it is fixed on the propeller boss, supposing the blade to be of uniform pitch?—E. B., Swansea.

Answer No. 1.—"E. B." Swansea, in his inquiry for a method of finding the pitch of a detached propeller blade before it is fixed on the propeller boss, does not tell us whether there be anything at the intended junction of the propeller blade and boss to fix and determine the angle of position of any section of the blade, with respect to the line of axis of the propeller shaft; as if there be such determinate fixity of the angle of position ascertainable, the pitch is easily found by the rule given in *The Practical Engineer* for July 6th, page 323, which may for convenience be reproduced here.

Let R = radius in inches described by any point P in the propeller blade.
,, p = pitch of propeller in inches.
,, A = angle of inclination of the surface of the propeller blade at the point P, with a plane perpendicular to the axis of the propeller.

Then $p = 6{\cdot}2832\ \mathrm{R} \tan \mathrm{A}$.

Assuming that there is apparently nothing to show what the angle of position of the blade on the boss will be when fixed there, and that as far as appearance goes it may have any angular position given to it; there is, however, but one proper angle of position for it, which is dependent on the dimensions and twist given to the blade between its root and tip, and which we will endeavour to determine.

In order to effect the above object, place a straight edge across the blade near each of its two extremities, and at right angles to its central or radial line, and take the measure of the angle between their positions, which will be the angle of twist the blade has between the two straight edges; the respective distances r and R of each of the straight edges from the centre of the shaft must also be determined.

If we now assume A, as before, to be the angle of the inclination of the outer extreme edge of the blade, with a plane perpendicular to the axis of the propeller, and B that of the inner extreme edge of the blade, with the plane as above, then (B − A) = the angle taken as above between the two straight edges, and having thus got the difference of the two angles, the proper value of each is now required; and because the pitch is supposed to be uniform, therefore,

$$p = 6{\cdot}2832\ \mathrm{R} \tan \mathrm{A} = 6{\cdot}2832\ r \tan \mathrm{B}, \text{ whence } \tan \mathrm{A} = \frac{r}{\mathrm{R}} \tan \mathrm{B}.$$

$$\text{By trigonometry: } \tan(\mathrm{B}-\mathrm{A}) = \frac{\tan \mathrm{B} - \tan \mathrm{A}}{1 + \tan \mathrm{B} \tan \mathrm{A}} = \frac{\tan \mathrm{B} - \frac{r}{\mathrm{R}} \tan \mathrm{B}}{1 + \frac{r}{\mathrm{R}} \tan^2 \mathrm{B}}$$

$$= \frac{(\mathrm{R}-r) \tan \mathrm{B}}{\mathrm{R} + r \tan^2 \mathrm{B}}, \text{ whence } r \tan^2 \mathrm{B} - \frac{\mathrm{R}-r}{\tan(\mathrm{B}-\mathrm{A})} \tan \mathrm{B} = -\mathrm{R}.$$

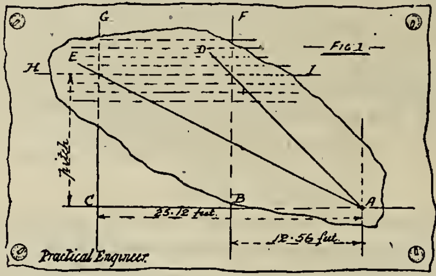
The solution of which quadratic gives $\tan \mathrm{B} = \frac{\mathrm{R}-r}{2r\tan(\mathrm{B}-\mathrm{A})} - \sqrt{\frac{(\mathrm{R}-r)^2}{4r^2 \tan^2(\mathrm{B}-\mathrm{A})} - \frac{\mathrm{R}}{r}}$

And B − (B − A) = A. And $p = 6{\cdot}2832\ r \tan \mathrm{B}$.

Although the above formula has a very formidable appearance, it is practically very simple, as the first fraction on the right-hand side of the equation is really so, and the next one under the radical sign is the square of the first, less $\frac{\mathrm{R}}{r}$.—W. A.

Answer No. 2.—I presume that "E. B." is able to ascertain, first, the distance from centre of boss to the face on which the blade is bolted, and secondly, that some mark exists upon the bolting down flange of the blade denoting its relation to the centre line of the boss. If such is the case, then I should suggest that "E. B." proceed as follows:—

Bolt the blade up to a suitable "angle plate" in such a position that the marks upon the flange are horizontal or vertical, as the case may be. Then proceed, as shown in my answer to "Port Glasgow," in *The Practical Engineer* of July 27th (see also issues for August 10 and 17), by dropping a plumb line, or, if upon a surface plate, by the use of a square, to obtain the necessary angle at any diameter; and then to calculate the pitch from the proportion—"As the arc of the circle—of which the distance G (see the above answer) is the chord—is to the circumference, so is the distance F to the pitch required." If "E. B." cannot find the necessary marks denoting the position of the blade upon the boss, then his task will be a little more difficult, but taking for granted that he knows for certain that the pitch *is* uniform, and also that he has the size of the boss, let him get some one to hold a straight-edge upon the blade at say (x) a radius of 2ft. from the centre of propeller shaft, and then by means of a bevel placed at (y) double the distance, say 4ft., let him sight the straight-edge in order to obtain on the bevel the *difference* between the angles of the blade at x and y, that is the angle which the blade at x makes with the blade at y: let this angle be D A E, as shown in fig. 1. Next draw the angle thus obtained upon a piece of tracing paper, and then upon a piece of drawing paper draw the vertical and horizontal lines shown upon fig. 1, where the distance A B equals the circumference of 4ft.—to any convenient scale—and the distance A C equals twice that amount, or the circumference of 8ft. At these positions erect the perpendiculars B F and C G, and parallel to C A draw a series of lines at various distances from the line C A—say at intervals of three inches—to the same scale as used for the distances C A and B A. Note.—These lines need only be drawn somewhere about, more or less, than the probable pitch of the propeller.



Now stick a pin through the point of the angle D A E on the tracing paper and into the drawing paper at the point A, so that the tracing paper may turn upon the centre A. Then move the paper about until the intersection of the oblique line D A with the vertical D F, and also the intersection of the oblique E A with the vertical D C E takes place upon a horizontal line common to the two, as shown to be the case in the figure where both the intersections occur on the line H I, Then the distance between the parallels C A and H I, measured to scale, will give the required pitch in feet.

If I have not made myself sufficiently clear. I shall be pleased if "E. B." will write again stating his difficulty.—Omicron.

Automatic Brake for Locomotive.—Will any reader tell me where I can find a sketch and description of an automatic brake for a locomotive?—Soyez Fume.

Answer.—"Soyez Fume" will find a full description of an automatic brake in your contemporary, "Engineering," for March 9th, 1888.—F. S.

Energy of Moving Body.—If a weight of 500lb. moves with a velocity of 75ft. per minute, what weight would it raise up an incline rising 12 in 163, if the maximum velocity of the weight to be raised is 8ft. per minute.

Answer.—In one minute the work performed by the falling body will be

$$500 \times 75 = 37{,}500 \text{ foot pounds.}$$

In the same time the rising weight will have been lifted through

$$8 \times \frac{12}{163} = \frac{96}{163} \text{ of a foot.}$$

Since the work done on the rising body will be the same as that given out by the falling body, therefore, if W = weight of rising body in pounds, we have, neglecting friction,

$$\frac{96}{163} \times \mathrm{W} = 37{,}500,$$

$$\text{and } \mathrm{W} = \frac{37{,}500 \times 163}{96} = 63{,}671\text{lb.}$$

High-speed Shafting.—Would any reader conversant with the above kindly explain the advantages of running a line shaft at 1,000 revolutions per minute for driving spinning machinery? Suppose a line shaft running at 1,000 revolutions per minute, the driven shafts on the machines not to exceed 600 revolutions per minute, driving pulleys 12in. diameter, driven pulleys 20in. diameter. If the line shaft was run at 600 per minute, having pulleys equal in diameter, would there be any disadvantage compared with the first arrangement?—P. C.

Answer.—The advantage of running shafts at a high speed is that with a lighter shaft a greater amount of power may be transmitted. Other things being equal, the diameter of the shaft, considering the torsional force alone, would vary inversely as the cube root of the number of revolutions per minute; so that if the main line shafting referred to in the query were reduced from 1,000 to 600 revolutions per minute, the sectional area of the shaft would require to be nearly doubled, a matter of no small moment when the total amount of shafting in a mill is taken into consideration. Torsional force alone is not, of course, the only point to be considered in the designing of shafts, as the question of stiffness between the bearings also comes into play, and in practice imposes a limit on the speed.—Ed.

Hardening Steel.—Can any reader inform me if there is any book published on the hardening and tempering of steel, explaining the why and the wherefore? If so, what is the price, and by whom is it published?—Coot.

Answer.—A very good treatise on this subject is contained in Shelley's "Workshop Appliances," published by Longmans, Green, and Co., price 3s. 6d.

Square-threaded Screws.—Can any of your numerous readers give me any information with regard to square-threaded dies, and why they are not more generally used?—J. M. G.

Answer.—Square-threaded dies are difficult to make satisfactorily, and strip easily; the wear in them is heavy, and they consume a lot of power when in use, as the cutting edge is large and the clearance poor. A square-threaded nut or screw can be as quickly formed in a lathe as with a die or tap, and in a much better and cheaper manner, for the amount of metal to be removed is large as compared with V threads.—G.

Whitworth's Fluid Compressed Steel.—I should be glad of any information regarding the manufacture of this steel.—J. M. G.

Answer.—This steel is manufactured in a Siemens-Martin furnace with the usual gas producers, regenerators, &c., and from which it is run into strong iron-bound vertical moulds. A heavy pressure is applied during the cooling by means of an hydraulic press acting on the top of the, at first, liquid metal. The compression resulting is very great.—G.

Radiation.—What is the rule for finding the radiation of heat from a boiler, say working at 30lb. pressure, ½in. shell, with temperature of atmosphere at 65 deg., the boiler to be fixed vertically?—W. R. E.

Answer.—The rate of the radiation determined by external resistances alone, with water on one side of the plate and air on the other, may be found by obtaining the co-efficient due to the nature and temperature of the substances, by the following:—

$$\text{A (co-efficient of external resistances)} = \frac{1}{1{\cdot}58\left\{1 + {\cdot}0037\,(T^1 - T)\right\}}$$

T^1 for steam at 30lb. = 275°
T the given air temp. = 65°

$(T^1 - T)$ or diff. = 210°

∴ A = 2·8 say.

Add to this the influence of internal resistance:—

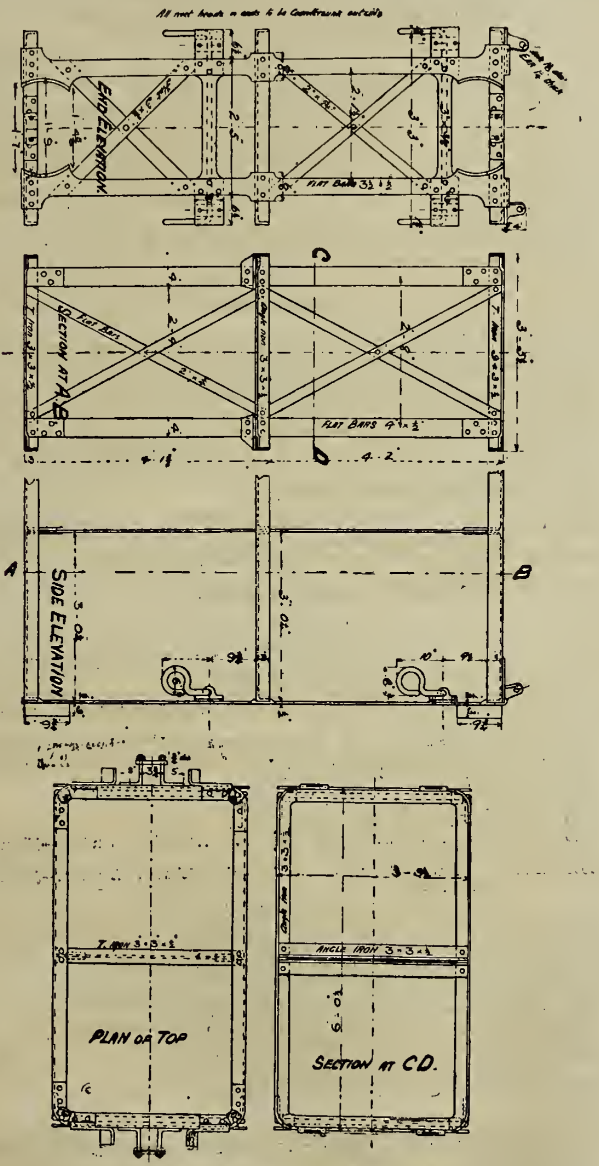
$B = e\,x$ – where x = thickness in inches, and e = ·0043; or B = ·0043 × ·5 = ·002 say.

Then quantity of heat per hour per square foot of area of surface is:—

$$Q = \frac{T^1 - T}{2{\cdot}8 + {\cdot}002} \text{ or about } 7\tfrac{1}{2} \text{ British thermal units.—G.}$$

Deck Cage for Mine.—A sketch and description of a deck cage and supports for mining purposes would be much appreciated by Junior Draughtsman.

Answer.—I enclose a sketch of a deck cage, which will probably give "Junior Draughtsman" the information he requires.—Straightedge.



DRAWING OF DECK CAGE FOR MINE.

Speed and Friction of Pumps.—I should feel greatly obliged if you would inform me what is the best working speed of bucket, plunger, and other pumps, in feet per minute, and what percentage extra they could be worked up to in case of an emergency (I suppose the depth of lift would affect the speed); also what is the friction of water in pump trees?—W. R. Evans.

Answer.—Deep well pumps should not be run higher than 100ft. per minute, and 60ft. to 80ft. is more satisfactory, as the heavier the pressure (or height of lift) the more severe the knock and wear on the valves and seats. In fact, under any speed at heavy pressures it is advisable to have wood seats and Tangye's well-known rubber cushion or rubber valves. Air pumps are often run at 500ft. to 600ft. per minute, with double-acting piston pumps, but the valves have to be the same area as the pump, and made of rubber. Plunger pumps can be run at much higher speeds than this if working entirely under water, the large surface of which is made to act as the suction and delivery agent. The real limit in any case is the wear of the valves, and the getting rid of air or steam.—G.

Helical Wheels.—Can any of my fellow-readers inform me of the best mode of setting out the teeth of a pair of bevel helical wheels, the larger wheel to be 34·8in. diameter, with 6in. face and 73 teeth, 1½in. pitch, and the smaller one or pinion 18·14in. diameter, with 6in. face and 38 teeth 1½in. pitch? Also a plain spur wheel 77·98in. diameter, with 140 teeth, 1¾in. pitch, to work in a pinion 40·1in. diameter, with 72 teeth. Any information with regard to making the patterns would oblige.—J. W. J.

Would some reader kindly inform me what is the proportionate strength of helical wheels in comparison with spur wheels having similar diameter, pitch, and face; also what is the rule for finding the breaking strength of helical wheels?—W. R. E.

Weighing Machines.—Is there any book published dealing specially with the construction of these machines, and what is the price?—T. D.

Dip of Fault.—Would some of your able correspondents kindly explain to me what is meant by the "dip" of a fault? For instance, a fault is said to have a bearing of N. 45° W. and dips N.E. about 15in. per fathom. I understand all about the bearings of faults, but I am not quite clear about the dipping of them.—St. Luke.

Spiral Springs.—Referring to the formulæ that have already appeared in the query columns of *The Practical Engineer* with regard to this subject, I should esteem it a favour if your correspondent "W. A." would kindly give me the rule for spiral springs of *rectangular* section.—Scoto.

Accidents to Marine Engines.—Will some correspondent tell me whether a book has recently been published dealing with accidents to marine engines at sea?

Chilled Furnace Bars.—Can any of your readers give me any information with regard to chilled furnace bars? To what depth can they be chilled from the top surface? Is it difficult to cast chilled bars any length—say 6ft.? What difference does it make in the nature, temperature of fusion, and also cost as compared with ordinary furnace bars?—Durability.

Relief Pipe on Hot Well of Marine Engines.—In steamships, a pipe is generally attached to the hot well, almost always as high as the engine room will allow, and brought down again to the bilges. Will some of your readers kindly explain the use of such, and the necessity for it being carried such a height? Why would it not do lower, or a relief valve supply its place.—D.P

Tanite Emery Wheels.—Can some reader furnish me with the address of the makers of tanite emery wheels?—E. C.

Olive Oils.—I should be pleased if any of your readers would furnish me with an easy method for testing the purity of olive oils.—M. Barker.

Winch Barrels.—Many thanks to "W. A." for the formula regarding winch barrels. There is one thing I should like to ask, it is this: Is the thickness of metal of the barrel not taken into account? I think it ought to be. If "W. A." will kindly give me light upon this I shall be greatly obliged to him. Also, if possible, to give me a formula where the thickness of metal is taken into account.—Nimrod.

TO CORRESPONDENTS.

J. Smith.—You will find an answer to your inquiries given in reply to "Marine Engineer," in our last issue, page 467, and a reference to the Board of Trade memoranda therein referred to will, we think, give you all the information you require.

P. D.—Thanks for your kind appreciation of our efforts conveyed in your communication of the 28th ult. The course you recommend has been tried; but the agents unfortunately do not take much interest in pushing the sale of a cheap technical paper, and we have therefore to rely largely upon the intrinsic value of the *P.E.*—of which we receive numerous proofs similar to yours—pushing its own way, and upon every reader being more or less of a friend, and doing his best to help us by circulating a knowledge of our existence.

J. S.—The velocity of the belt will be that of the rim of the driving wheel, and as this is 6ft. diameter, its circumference will be 6 × 3·1416 = 18·8ft. Multiplying this, therefore, by the number of revolutions, you have 60 × 18·8 = 1128ft. per minute as the velocity of the belt. The diameter of the smaller or driven pulley, will not affect the velocity of the belt in the least.

MISCELLANEA.

New Gas Engine.—It is reported that M. Otto, the inventor of the gas engine, has constructed a new machine which automatically prepares its own gas by means of the Dowson apparatus. The new model is of 8 H.P., and only consumes 2lb. of coal per H.P. per hour.

Breaking of an Atlantic Cable.—The Anglo-American Company's Brest-St. Pierre cable broke last Monday. This is the old 1868 cable, which was only repaired on the 28th of July last. It has always been a source of trouble and expense to the Anglo-American Company—in fact a new cable could have been laid with the money expended in repairs of this cable.

Progress of the Air Brake.—Eighteen years ago, when the air brake was tried, it required eighteen seconds to apply it to a train 2,000ft. long. Four years later the time was reduced four seconds. Recent experiments with the air brake on freight trains show that it can be applied to every car on a train of that length running at the rate of forty miles an hour, and that this train can be stopped within 500ft., or one-fourth of its own length, and without any serious jolting.

A Large Terrestrial Globe.—According to *Nature*, a large terrestrial globe, constructed on the scale of one-millionth, will be shown at the Paris Exhibition of 1889. A place will be set apart for it in the centre of the Champ de Mars. The globe will measure nearly 43ft. in diameter, and will give some idea of real dimensions, since the conception of the meaning of a one-millionth is not beyond the powers of the human mind. Visitors to the exhibition will see for the first time on this globe the place really occupied by certain known spaces, such as those of great towns. Paris, for instance, will barely cover a square centimetre. The globe will turn on its axis, and thus represent the movement of rotation of the earth. The scheme was originated by MM. T. Villard and C. Cottard, and *Nature* says that it has been placed under the patronage of several eminent French scientists.

The New Magazine Rifle.—Major-General Philip Smith, C.B., the President of the Small Arms Committee, has issued his report upon the experiment made at Aldershot on the 21st ult. with the new rifle at long ranges. The report states that the target represented a battalion of seven companies, each of twenty-seven file, standing in quarter column. The front company was represented by iron and wood screens, the remaining companies by wooden screens of thickness varying from a quarter to three-quarters of an inch. At 2,000 yards 43 per cent of hits were obtained; at 2,400 25·90 per cent; and at 2,800 14·90 per cent. A heavy mist caused the target to be absolutely invisible at all the ranges, therefore the fire had to be directed by using an intermediate object to aim at. It may therefore be described as indirect fire, and consequently most instructive to the troops engaged and those witnessing the practice. At 2,800 yards the bullets penetrated the wooden screen and were flattened against the iron screens.

The Clyde Shipbuilding Trade.—The shipbuilding trade during the month just closed has been very active both in regard to launches and still more in the booking of new orders. The rush at the end of August, when 38,000 tons of new shipping were ordered, was continued for the first three weeks of September, and the vessels contracted for within that period reached a total of 65,000 tons. The work now on hand is therefore double what it was at the same time last year. In January the production was equal to 13,381 tons; February 2,674; March 25,265; April 17,882; May 13,670; June 21,370; July 23,950; August 29,339; and September 35,730 tons. The total for the nine months is about 184,000 tons, which is not only greater than the production in the corresponding periods of the three preceding years, but is within 1,100 tons of the total output last year and 12,000 tons greater than the total figure in 1886. The contracts booked, as already indicated, represent 65,000 tons. The contract prices advanced by from 10 to 15 per cent. during the month, steel having gone up something like 7s. 6d. a ton, and shipbuilders have now practically decided to advance wages by 5 per cent.

Opening of New Railways.—Three new railways were opened for traffic on Monday last. The first is the London and Brighton Company's new line between Oxted and Groombridge. The new line, which is about 15 miles in length, will place Eastbourne in more direct communication with London, the distance from London being thereby reduced from 49 miles to 35 miles. The second is the London, Tilbury, and Southend Company's new and shortened route from Barking, via Upminster and Pitsea. The line was opened for traffic in the early portion of the year, but the great storm in August having washed away portions of the line, it was obliged to be closed for re-construction, which has now been effected. Another new line is the London, Chatham, and Dover Company's extension from Blackheath to Greenwich. Although the line is scarcely three-quarters of a mile in length, it has involved a heavy outlay. The opening of this line will give the company and the town of Greenwich several advantages. Greenwich will be placed in direct communication with the Crystal Palace, while the company's metropolitan extension line westward will give access to Victoria and the West End, and also to the city at Ludgate Hill.

Society of Arts Engine Trials.—The trials of motors organised by the Society of Arts are now being carried out at South Kensington in a shed standing on what was once known as the Horticultural Society's Gardens, and recently handed over to the contractor for the building of the Imperial Institute. The trials are being conducted by Professor Kennedy, Dr. Hopkinson, and Mr. Beauchamp Tower, but the results cannot be made public for some time, in consequence of the heavy calculations involved. The rewards offered are four gold and four silver medals, and there was hardly any limit laid down as to the nature of the motor. There was a considerable number of entries, but these have dwindled away from one cause or another, and nothing remains but one steam engine and three gas engines. The steam engine is a compound portable, by Messrs. Davey, Paxman, and Co., Colchester, and is very similar to that which carried off the prize at Newcastle last year. The cylinders, 5¼in. and 9in. diameter by 14in. stroke, are carried on an independent wrought-iron frame on the top of the boiler, which is thus spared heavy strains. The pressure is 180lb., and the engine indicated just 20 H.P. The gas engines are: Atkinson's, entered to work at 9¾ H.P.; Crossley's, at 14 H.P.; and Griffin's, the same.

SELECTED PATENTS.

APPLICATIONS FOR LETTERS PATENT.

September 21st.

13628 Helical Spring Lock-nuts, P. J. Wilson, Dore.
13629 Brush Holders, W. H. Scott, Norwich.
13630 Self-setting Ratchet and Clutch Gearing, H. Thomson, Buckden.
13635 Sow Boxes, H. Livesey and T. Gill, Halifax.
13637 Looms, W. H. Duckworth, Halifax.
13642 Crank Shafts, H. Foster, Newcastle-on-Tyne.
13644 Lithographing and Zincographing, J. L. Mills, London.—[Complete Specification.]
13646 Polishing Metals, J. Dean and G. H. Kingsley, United States.—[Complete Specification.]
13647 Sewer Gas Traps, H. C. Montgomery, United States.—[Complete Specification.]
13655 Centrifugal Apparatus, D. Stewart, Glasgow.
13659 Machinery for Slicing Cocoanuts, W. T. Linton, London.—[Complete Specification.]

September 22nd.

13684 Retaining Valves, A. Kaiser, London.
13685 Pressure-reducing Valves, A. Kaiser, London.
13696 Brick Kilns Fired by Gas, C. H. Scott, Sheffield.
13702 Dyeing Textile Materials, J. G. Sington, of the firm of A. Sington and Co., Manchester.
13709 Automatic Anti-snarling Motion, D. Marsland, Manchester.
13711 Portable Steam Sawing Machines, W. Neal, London.
13712 Supporting Rods Working Railway Switches, &c., L. B. Stevens, London.
13717 Automatically Feeding Electric Batteries, S. Eloesser, London.
13718 Means for Working Mines, C. Meissner, London.
13719 Communication on Railway Trains, J. Thornton and W. Walker, London.
13720 Lightning Conductors, S. A. Varley and G. Driver, London.
13725 Electrical Contacts, T. M. Sargeant, and O. R. Swete, London.
13726 Lubricating Apparatus, G. Paley, London.
13727 Nail-making Machines, J. J. Cordes and Co., London. (F. J. Mitche Italy.)
13729 Drilling Machines, T. Townsend, London,
13731 Pumps, E. H. C. Oehlmann, London.—[Complete Specification.]
13732 Preventing Collisions, H. G. Held, London.—[Complete Specification.]
13741 Machinery for Manufacture of Paper, H. Schulte, London.

September 24th.

13742 Alloys, H. Eckardt, Berlin.
13744 Engine Worked by Compressed Air or Steam, J. Hailwood, Sheffield.
13750 Steam Boilers, R. Jahar, Berlin.
13751 Pegging or Nailing Machines, T. Gare, Stockport.
13752 Automatic Brake, G. Kyte and A. F. Williams, Cardiff.
13753 Hydrogen Gas, J. A. Wanklyn, London.
13762 Bolts and Nuts, T. H. Ramsden, Leeds.
13766 Safety Saddle Bar, H. J. Macey and J. Hopkins, Kilburn.
13769 Engraving by Sand Blast, A. J. Boult, Middlesex. (C. F. Josz, Belgium.)
13775 Lubricators, J. H. Orr, Glasgow.
13776 Feed-water Heaters, T. W. Bayes, London.
13781 Valve Gear, G. F. Redfern, Middlesex. (E. J. Woolf and J. F. Williamson, United States.—[Complete Specification.]
13785 Machinery for Manufacturing Boxes, J. R. Thame and H. Sanguinetti, London.
13795 Melting Metals, C. A. Sahlström, London.

September 25th.

13808 Cranks, C. Whitley, Worcestershire.
13813 Steam and Motive Power Engines, A. J. Boult, Middlesex. (H. Hurdle, United States.)—[Complete Specification.]
13824 Shaping Nuts, &c., K. Banks, London.
13826 Wire Nails and Machines, E. Fontaine, United States.—[Complete Specification.]
13830 Manganese Alloys, O. M. Thowless, London.—[Complete Specification.]
13832 Feed-water Governor, W. R. Pether and R. W, Papineau, Battersea.
13835 Belt Fastener, F. B. Stanton, London.
13840 Forced Draught, H. Williams, Glasgow.
13843 Steel and Iron, H. J. Smith, Glasgow.
13846 Tension Wheels, C. Bescherer, London.
13850 Filtering and Clarifying Oil, H. Hamelle, London.—[Complete Specification.]
13851 Heating and Purifying Water, W. Webster, London.—[Complete Specification.]

September 26th.

13858 Equilibrium Valve, A. Ball, jun., Manchester.
13862 Steam-hammers, S. Massey, Manchester.
13863 Yarn-winding Machinery, J. D. Whyte, Manchester.
13879 Heating Feed Water, A. Howatson, London.
13884 Alloys of Copper with Iron or Steel, L. Q. Brin, London.
13885 Consumption of Smoke, R. Sickel, London.
13886 Furnace Grates, G. Torry, London.—[Complete Specification.]
13887 Motor Apparatus, H. Ward, London.
13889 Elevators or Lifts, P. M. Justice, Middlesex. (C. R. Otis, United States.)—[Complete Specification.]
13894 Separating Milk, W. W. Beaumont, London.

September 27th.

13895 Self-acting Barrel Tilter, M. Barlow, Manchester—[Complete Specification.]
13901 Grinding Rollers, J. E. Platt and J. Fidler, Manchester.
13902 Carding Machines, W. H. Greenwood and F. Farrar, Bradford.
13905 Vices, J. Foulds, Keighley.
13908 Interlaced Metal Belting, E. Wright, Sheffield.
13912 Railway Fog Signals, R. Bateman, Birmingham.
13919 Couplings, J. Darling, Glasgow.
13921 Wheels, J. Wiley and T. Edge, London.
13923 Cranes, M. E. Sugden, London.
13930 Railways, C. P. Espinasse, London.
13936 Filtering Apparatus, H. F. Clayton and G. H. Holdroyd, Huddersfield.—[Complete Specification.]
13937 Transmitters, P. Neil, London.
13938 Crank and Treadle Movement, W. R. Clark, London.
13941 Cutting Wool Burs, H. L. Offermann, London.
13942 Wire Ropes, R. Dixon, London.

PUBLISHERS' ANNOUNCEMENTS.

BACK NUMBERS of "The Practical Engineer," from the commencement, can be obtained at either of our offices in London or Manchester, or by order of any Newsagent.

Vol. I. (bound), containing Nos. 1 to 44 inclusive, from March to December, 1887, price 6s. 6d., can still be obtained by order from any Newsagent, or will be forwarded, carriage paid, from either of our offices on receipt of the amount by postal order or stamps.

Numerous complaints having been made to us by Subscribers of the difficulty they experience in obtaining copies of the *Practical Engineer* in certain districts, we have to state that the Journal can be obtained by any Newsagent through the ordinary trade channels, and no difficulty should therefore exist in obtaining copies by order of any Newsagent.

For the information of the trade, we may state that copies can be obtained from either of our Offices in London or Manchester, or from any of the following wholesale houses.

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W. H. SMITH & SON, Blackfriars Street, Manchester.
JOHN HEYWOOD, 11, Paternoster Buildings, London, and Deansgate, Manchester.
ABEL HEYWOOD & SON, Oldham Street, Manchester.
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&c., &c., &c.

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EDITORIAL NOTICES.

All communications for the Editor of this Journal should be addressed to 6, Victoria Station Approach, Manchester.

Communications intended for insertion in the current week's issue should reach us not later than Tuesday Evening.

We cannot undertake to return rejected manuscripts or drawings unless accompanied by a stamped and directed envelope.

Contributors are requested to write on one side only of the paper. Sketches should be sent on separate sheets.

TO ADVERTISERS.

Advertisements intended for insertion in the current issue should reach us on Wednesday morning at the latest.

THE
PRACTICAL ENGINEER.

OCTOBER 12TH, 1888.

TRADE TRUSTS.

For some weeks past paragraphs have been appearing from day to day describing the progress made by a financial syndicate in purchasing the various extensive salt manufacturing industries throughout Cheshire, and it is stated that in consequence of the progress already made, and an early prospect of a considerable rise in the price of salt, the shares of the various companies have increased by nearly 50 per cent.

We must own to a feeling of considerable regret at the introduction into British industrial enterprise of an element so pernicious in character, and destined, in spite of the ephemeral success resulting therefrom, to result ultimately in widespread misery and depression. Trade trusts are institutions that have been developed to a pretty large extent in America, but no impartial observer can, we think, assert that their growth in the United States has been beneficial to any but a few of the gamblers who have pulled the strings.

The avowed object of such trusts is to inflate the price of the article concerned far beyond the point at which it would be fixed by the ordinary law of supply and demand. Although the immediate attainment of this object may to a cursory observer demonstrate the success of the combination, yet it is not difficult to see that the process by which immediate profits are secured is very much equivalent to that of "robbing Peter to pay Paul," and that the future prospects of the trade are jeopardised to an extent that more than counterbalances any immediate advantage gained.

One natural result of such an artificial attempt to inflate prices is that additional capital is sunk in the industry, and thus brings into play the competition of capitalists who are not "in the swim." The inevitable sequel to this is over-production, the ultimate effect being that when the syndicate collapses, as collapse it must sooner or later, a competition is brought into play between rival capitalists that is all the greater for having been restricted by the "trust" in the first instance. The temporary success which has attended the efforts of several continental financiers in this direction, and in regard to which the recent abnormal rise in the price of copper may be taken as an illustration, is no doubt responsible to some extent for the formation of the salt syndicate.

As already stated, we regret the introduction of such an artificial element into our commercial life, feeling sure that it will in the long run exert a blighting influence upon industry. Any advantage in the way of enhanced profits that may be reaped will be but transitory, and many of those now joining the combination will bitterly regret the day they were led to believe that, because the price of a commodity could be temporarily raised by interposing an artificial barrier to the flow of production, the natural law of supply and demand would not, sooner or later, break it down, and result in an unnatural flood of competition that might otherwise have been avoided. "Salt Syndicate" is only another expression for Salt Monopoly, and trade monopolies, like all others, sooner or later break down. When the inevitable collapse occurs the ephemeral profits which may be reaped for the moment will rapidly melt away, and the truth will once more be forced upon unwilling minds that success in business is attained not by gambling, but by steady, plodding perseverance and hard work.

THE ELECTRIC LIGHT ON THE SUEZ CANAL.

The use of the electric light for the purpose of night navigation of the Suez Canal, which has now been in operation for about two years, has proved a perfect success, the average time of passage of the canal since the adoption of the electric light having been reduced by one half. The carrying capacity of the canal has been severely tested by the rapid development of the traffic, and it will be remembered that about three years ago much dissatisfaction was expressed by shipowners on account of the repeated blocks experienced by vessels, and the prolonged time occupied in their passage through the canal. In order to meet the increase of traffic, the question of widening and deepening the channel throughout its entire length was seriously discussed. The great improvement, however, effected by the adoption of the electric light, by means of which the length of the working day has been practically doubled, has now done away with the necessity for this, or at any rate for some time to come, as the canal is now able to deal with the demands made upon it with comfort and ease, to the great advantage of the trading community. The illuminating apparatus consists of a projector search light of 12,000 candle power, which is mounted on a platform beneath the vessel's bows, and spreads a horizontal fan of light over the surface of the water, and clearly reveals the vessel's course for half a mile ahead. A second lamp of 6,000 candle power is fixed up aloft so as to illuminate the vessel itself, as well as a circular area around it. Many vessels now carry their own illuminating apparatus, but those not equipped with it may hire one at either entrance to the canal without causing loss or delay. From a paper recently published, it appears that during the first fifteen months of the introduction of this new appliance only twenty-five vessels adopted the light, whereas in May of the present year it was adopted by 139, or one half of the total number that made the passage.

The adoption of the electric light in this case is an apt illustration of the far-reaching benefits which science at times confers upon the commercial world. The usefulness of the canal, as already indicated, has been practically doubled at a stroke without necessitating the excavation of a single spadeful of earth. The money saving effected by the reduced time of passage under the heads of capital, demurrage, wages, provisions, &c., is of course enormous.

REVIVAL OF THE SHIPPING TRADE.

The gratifying improvement in the shipping industry of this country, and the remarkable increase in freights to which we alluded a short time ago, has been accompanied by a similar revival in the United States. It should be explained, however, that whereas the improvement on this side of the Atlantic has rendered itself manifest mainly in the construction of large vessels for the ocean carrying trade, the revival in America is restricted almost entirely to the construction of vessels for coasting and other traffic. Looking at the high American protective tariff, this is perhaps only what might be expected, for while the tariff practically renders it impossible for American shipowners to compete in the ocean carrying trade, the navigation laws of the Union restrict the coasting and lake trade to vessels of purely American manufacture. The revival in this branch of industry, however, is of interest in the present days of canal construction, as throwing a little side light on the relative cost of rail and water carriage, and it would seem that, notwithstanding the enormous extension of American railways in recent years, water carriage continues to hold its own. From the returns of the United States Commissioner of Navigation, it appears that 581 new vessels, with a total capacity of 150,110 tons, were registered in the "domestic marine" during the six months ending August last, as against 471 vessels, with a total capacity of 105,234 tons, during the corresponding period of last year, or an increase in tonnage of nearly 50 per cent, while it is added that all the new tonnage is finding very profitable employment.

Turning to the increase of freights in the home shipping, the rapid advance that has taken place is certainly remarkable. For instance, the average rate for sea carriage of ore from Bilbao to the Tyne was last year 5s. 5d. per ton, whereas it has now risen to over 7s. Grain from New York last year cost 3s. per ton for carriage, as against 5s. at present. From Nicolaieff home freights have risen from an average of 18s. 3d. to 27s. while timber freights from the Baltic have advanced nearly 50 per cent. Coasting freights, although usually slow to move, have already shown a distinct advance, as is indicated by the fact that while the average rate for coal carriage from the Tyne to London was last year 3s. 6d. per ton, it has this year reached 4s. 3d. per ton before autumn has passed.

Whether the present high freights will be maintained it is at present somewhat difficult to say. Looking, however, at the large amount of new tonnage at present in course of construction, and that the vessels are both greater in tonnage and number than the average, it is quite possible a slight falling off in the rates may be experienced as the vessels now on the stocks get launched. Up to the present, however, carrying rates remain quite firm, and the outlook in the shipbuilding trade is decidedly better than it has been for a long time past.

RAILWAY SERVANTS' CONGRESS.

Railway employés constitute such an important and large contingent in the nation's army of workers, that the proceedings of the Congress of the Amalgamated Society of Railway Servants, which has been sitting at Preston to discuss their wants and needs, cannot be allowed to pass without a word of notice. The death toll which is yearly levied on our railway workers is much greater than the general public would suppose. During the year 1887, it appears from the official returns, that no less than 470 railway servants were killed, while upwards of 6,000 others were more or less seriously injured. The figures, although less than those of the previous year, are still sadly too high, and the regret experienced by a contemplation of them is none the less painful when coupled with the reflection that much of this loss of life could be avoided. Considering the vital importance of the matter, it is not surprising that the subject occupied a position of primary importance in the discussions of the congress. From the fact that the larger proportion of those killed and injured are either goods guards, brakesmen, or shunters, it will be evident that the main portion of these accidents occur in connection with shunting operations, and a resolution was passed expressing the opinion that "many of these accidents were preventible, and could have been avoided by the more extensive adoption of safety appliances." With this opinion we think the majority of the public will agree. The contempt for ordinary precautions bred of familiarity with danger is doubtless responsible for some of the disasters which occur, but after making all due allowance on this score there can be little question that the present antiquated method of coupling and uncoupling railway wagons leaves much to be desired, and is hardly consistent with the present stage of mechanical science.

Reference was made in the discussion to the number of fatal accidents to platelayers, and the request that a man should be specially told off for the protection of each gang, for the purpose of giving warning of approaching trains, does not appear excessive in the absence of any mechanical appliance for the purpose. An electrical device has, we believe, been invented for this object, and, indeed, one of the delegates stated that on the line with which he was connected an appliance of such kind was at present in operation, an approaching train giving an alarm to the platelayers by ringing a bell.

The question of employers' liability and the doctrine of common employment is one that generally crops up for discussion at these gatherings, though we question how far the opinion of the congress that a workman should be entitled to compensation for any injury occurring through the neglect of a fellow-workman will commend itself to outsiders. Although the doctrine as at present recognised in the Employers' Liability Act may result in the infliction of occasional injustice upon workmen, it is, on the other hand, questionable whether its entire abrogation would not result in the infliction of quite as great an injustice upon employers. The point is, it must be admitted, a rather delicate one, and there is something to be said on both sides. In connection with this subject, the congress took exception to the limit of compensation at present awarded under the Employers' Liability Act as being insufficient, and a resolution was unanimously adopted that the amount should be at least doubled.

A number of other resolutions dealing with matters of general interest in connection with salaries, hours of labour, and sundry other questions came up for discussion, but want of space forbids our dealing with the proceedings in connection with these questions at greater length.

LITERATURE.

Text Book of Applied Mechanics for the use of Students in Science and Technical Schools. By THOMAS CRYER and HENRY G. JORDAN. Manchester and London: John Heywood. Price 3s.

WE are frequently asked by some of our junior readers whether we can recommend a good text book on applied mechanics—one suitably illustrated with examples, in order that the student may have an opportunity of testing his knowledge and making sure of his ground as he goes along. We must confess that hitherto we have experienced considerable difficulty in answering such questions. Applied mechanics is a subject covering a wide and somewhat indefinite field, and the fault of most of the books we are acquainted with which profess to deal with the subject is the lack of practical illustration in the shape of examples. Although this may not be a defect of serious moment to an advanced student familiar with the ground, yet it forms a serious stumbling block to the young reader. No objection, however, can be raised on this score with regard to the book before us, which deals with the subject in a way that clearly indicates the authors' familiarity with the difficulties of students, and from their experience as lecturers in the Manchester Technical School this is perhaps what might have been expected. The first chapter of the work is devoted to an enunciation of the fundamental principles regarding force, work, and horse power, &c., and a number of simple illustrations are worked out in order to more clearly impress upon the student the distinction between these various terms. The next chapter is devoted to the nature of friction, and the work expended in overcoming it. Other chapters follow, dealing with the simple mechanical powers, illustrated with practical examples of their application. Further on the book treats of motion and accumulated work, while a chapter is devoted to the strength of materials and another to hydraulic machines. The book, which is copiously illustrated, deals pretty fully with most of the questions that come under the head of applied mechanics, and is one which we can heartily recommend to the notice of every engineering student.

The Pump Catechism. By R. GRIMSHAW.

WE must confess that we have a strong objection to catechisms generally. This may possibly be a survival of an early prejudice, but we certainly fail to perceive what advantage is gained by treating a scientific subject in this way. A book which consists simply of a string of questions and answers, arranged alternately, does not strike us as being either convenient for reference or calculated to convey information in the most rapid way. We ought, perhaps, to say that the author in his preface remarks that the book is not intended for professional men, but for "practical pump users." Possibly some "pump users" may prefer to pick up knowledge by reading Mr. Grimshaw's cross-examination; but for our own part we should as soon think of consulting Joyce's scientific dialogues for information on a scientific subject as we should of consulting the book in question for information about pumps.

Designing Wrought and Cast Iron Structures. Part V. Notes, Calculations, and Drawings for a Wrought-iron Roof, Truss, and a Cast-iron Column. By HENRY ADAMS, M.Inst.C.E., &c., Professor of Eugineering, City of London College. Price, 1s. 6d.

THIS is one of a series of monologues which have been issued by the same author, illustrating in a practical manner the method of procedure required in designing various wrought and cast iron structures. In reviews of previous parts of this series we have had occasion to refer to their excellence and value, and in noticing the present one we need say little more than that it fully sustains the reputation of its predecessors. The method of designing a wrought-iron truss is illustrated with all the practical notes used in connection with an actual example for a span of 45ft., fitted with angle-iron purlins, common rafters, slate battens, and countess slates, while the designing of a cast-iron column is illustrated in a similar manner in connection with one 15ft. high, designed to carry a dead load of 30 tons over its centre line. The designs in each case are accompanied with detailed working drawings, and the monologue will be found of invaluable assistance to all who wish to become familiar with the application of the scientific principles of design to the structures referred to.

LORD ARMSTRONG ON RAPID-FIRING GUNS.

LORD ARMSTRONG, in presiding at the annual meeting of the shareholders of Messrs. Armstrong, Mitchell, and Co., on the 28th ult., referred to a new departure in artillery in the direction of rapid firing, which the firm were then making, and which he said had been attended with great success. The advantage of being able to fire rapidly at critical moments was, he remarked, obvious to all. In the first place, the increased rapidity of fire of each gun is tantamount to increasing the number of guns, without necessitating a corresponding increase in the number of gunners or in the collective weight of the shields required to protect them. In the second place, the great advantage is obtained of being able to repeat a successful shot before the enemy can materially change his position, which would render necessary a fresh adjustment of the gun. These salient advantages had, he said, been fully realised in their new guns of $4\frac{3}{4}$in. and 6in. calibre, with both of which a rapidity of fire has been obtained hitherto considered impossible with guns of so heavy a nature.

Great simplicity of design and strength of mechanism had been combined in the construction of these guns and their carriages, and with the improved descriptions of powder now coming into use, velocities had been obtained so great that the $4\frac{3}{4}$in. gun, weighing only 2 tons 1 cwt., was capable of piercing $10\frac{1}{2}$in. of wrought iron, while the 6in. gun, weighing 6 tons 15 cwt., could pierce 15in. of the same material.

These guns are mounted on specially designed shielded carriages, in which exceptional facilities in handling and aiming have been combined with great protection to the gunners, and in the numerous trials carried out the shooting has been characterised not only by rapidity but by unusual accuracy. The comparative rates of fire of the present breechloading service guns and the new improved guns could, he said, be judged of from the following instances :—

In some trials carried out last year with the $4\frac{3}{4}$in. gun by the Admiralty, ten rounds were actually fired in $47\frac{1}{2}$ seconds, whereas an ordinary breechloading gun of the same calibre, firing in competition, took five minutes and seven seconds to fire the same number of rounds. Again, the great accuracy of the guns, combined with the rapidity of the fire, was illustrated by the fact that five rounds were fired a few weeks ago at Shoeburyness, in which, at a distance of 1,300 yards, a target 6ft. square was hit five times running in 91 seconds.

Lord Armstrong said he was glad to say that the Admiralty had been prompt to recognise the value of these guns by adopting both of them for the British service. It was, however, he said, in dealing with the attack of torpedo boats at sea that the advantage of being able on occasion to fire with great rapidity became most apparent.

Supposing a torpedo boat to be sighted at a distance of 1,500 yards by a war vessel having a broadside armament of three ordinary service 5in. breechloading guns, each capable of firing at a maximum rate of two rounds a minute. The torpedo boat could not hope to discharge a torpedo with much certainty at a longer range than 200 yards, and would, therefore, have to traverse a distance of 1,300 yards under fire before she could herself attack. Assuming the speed of an ordinary first-class torpedo boat to be 20 knots an hour, the time occupied in traversing 1,300 yards would be, roughly speaking, two minutes. The war vessel, therefore, thus armed would be able to discharge only 12 shots at the torpedo boat before there was a chance of being herself torpedoed. If, however, in lieu of the three service 5in. guns she was armed with three of the improved rapid-firing 4¾in. guns, she could in the same time, and with the same number of gunners, fire no less than 72 shots, each gun being capable of firing 12 shots a minute; and any one single hit must prove fatal to the torpedo boat.

Concurrently with this improvement in guns, a new departure had been made in the manufacture of powder. The firm had been and were still experimenting with a new powder for the quick-firing guns. It is made by the Chilworth Company, and notwithstanding that the charges had been reduced in weight by about one-third, they had obtained velocities of from 2,300ft. to 2,400ft. per second, as compared with velocities of 2,000ft. previously obtained with other powders. This new powder, moreover, leaves no residue in the gun to interfere with the essential requirement of rapid loading, and the smoke has been so far reduced as to present little obstacle to the sighting of the guns in action—advantages that can scarcely be over-estimated.

On many occasions he had, he said, commented on the important *rôle* protected cruisers must play in any naval war of the future; and his firm was the first to recognise this fact, and had earned a well-merited reputation for this class of vessel.

Last month they launched a cruiser, the Piemonte, for the Italian Government, which would, he thought, still further increase that reputation. Beginning with the Chilian cruiser, Esmeralda—depending for her protection chiefly on a submerged deck—they had launched a series of vessels of the same type, each presenting improvements on its predecessor, and by continued advance in this course of improvement, and by the employment of quick-firing guns, had produced in the Piemonte a cruiser of surpassing speed and offensive power. Her displacement, he said, was only 2,500 tons, and yet her speed would be 21 knots, equal to 24 miles per hour, and the coal capacity of her bunkers was sufficient to enable her to steam about 17,000 miles at the most economical speed without re-coaling.

But it was in her offensive power that her pre-eminence was most decided. In addition to a complete torpedo equipment and a full complement of Hotchkiss and Nordenfelt guns, she carried an armament of six 6in. and six 4¾in. guns, all of the improved type. The extraordinary power of such an armament would, he said, be best appreciated when it was stated that the Piemonte would be capable of discharging against an adversary in a given time twice the weight of shot and shell that could be fired by the largest war vessel now afloat, not excluding the leviathan battleships of five or six times her size, which could ill withstand the torrent of shell which the Piemonte could pour into the large unarmoured portions of their structure.

Referring to the attention which had been directed by the naval manœuvres of the past summer to the necessity for the more efficient protection of our commerce at the various centres on the coast to which it converges, he said much had been written on the possibility of extemporising a naval defence for the purpose; but it appeared to him that the true solution of the problem lay in the construction of specially built vessels similar to the Piemonte, but smaller in size, seeing that for protecting commerce off the coast a large coal-carrying capacity was not an essential, because such vessels could return to port whenever required for re-coaling.

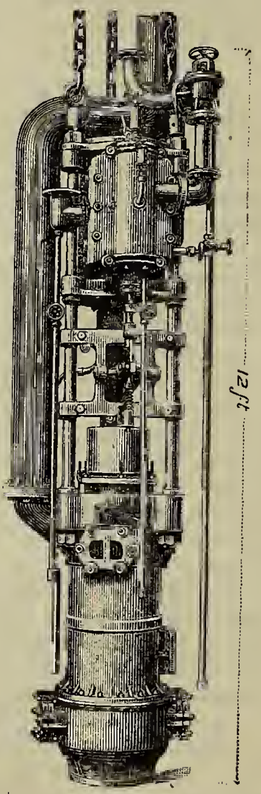
For patrolling our coasts he thought great speed was of vital importance, and for attacking an enemy a powerful armament equally so. One vessel such as he had indicated would be a match for a whole fleet of armed merchantmen collectively of far greater money value, and we should best attain both economy and security by providing the right thing for the purpose in view.

The proposal lately made for each port to patrol the neighbouring sea by steam tugs or other vessels manned by volunteers was, in his opinion, simply trifling with the problem of commercial defence.

The introduction of rapid-firing guns of the heavier natures, combined with the use of Watkins's range-finder, which could only be used on land, would, he thought, give to shore batteries greatly increased efficiency, and enable them to operate with great effect against ships endeavouring to enter our harbours.

NEW SINKING PUMP.

We illustrate herewith a new form of sinking pump made by the Pulsometer Engineering Company, who have acquired a well-deserved reputation for specialties of this class. The pump is of the bucket and plunger pattern, and is capable of raising about 500 gallons per minute through a height of 150ft. The passages in the pump are arranged so that the water has almost a perfectly straight course in its passage from the suction to the discharge pipe. The diameter of the steam cylinder is 18in., while that of the bucket is 18½in., and the plunger 13in., the stroke of both cylinder and pump being 2ft. The pump is very compact, the floor space occupied being only 3ft. 6in. square, while the weight is about 57cwt.



It will be observed that the connections are so arranged that the weight of the pipes is conveniently supported by the pump, which can be suspended from a crab placed on the surface. Dogs are also provided for convenience in attaching the pump to the pit timbers when required, while if the water is very gritty, a plunger may be substituted for the bucket, as in the case of the firm's double plunger sinking pumps.

THE BIRMINGHAM BOILER EXPLOSION.

The inquest on the four men who were killed by the boiler explosion which occurred at the works of Messrs. Watson, Todd, and Watson, flour millers, 81, St. Vincent Street, Birmingham, on Saturday, the 29th ult., was opened before the Birmingham borough coroner on the 2nd inst. After formal evidence of identification, however, had been taken with regard to the deceased, the inquiry was adjourned till Tuesday, the 16th inst., in order to permit of the boiler being examined by an independent engineer, and a report prepared for the jury.

MESSRS. STEVENSON & CO.'S AUTOMATIC EXPANSION MOTION.

The two-page engraving accompanying our present issue represents an automatic expansion motion (Messrs. Stevenson and Price's patent), brought out by Messrs. Stevenson and Co., of Canal Foundry, Preston.

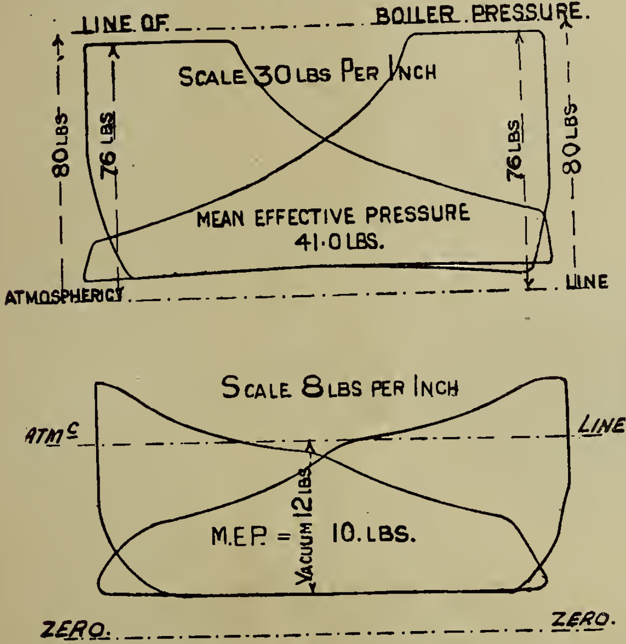
The engravings show the motion applied to the high-pressure cylinder of a horizontal compound engine, 36in. diameter, 6ft. stroke, running at 40 revolutions per minute.

Fig. 1 is a front elevation, with steam chest in section; fig. 2, a cross section through both valves; fig. 3, a half longitudinal section; while figs. 4, 5, and 6 are detailed views of the cam box to a larger scale.

Referring to figs. 1, 2, 3, it will be seen that there are a pair of valves, each consisting of a main valve and an expansion valve arranged at each end of the cylinder. The main valves RR are of the ordinary slide construction, with the addition of grid openings on the back, through which all steam supply to cylinder must pass.

The cut-off valves SS consist of cast-iron grids, lifting at right angles to the main valves RR by the spindles NN. Air cylinders are provided for cushioning the "cut-off" stroke of the expansion valves. This is effected without the usual spiral spring arrangement, the dead weight of the valves and their spindles alone shutting them down instantaneously when released on the upward opening stroke. The motions of the cut-off valves are controlled by bell-crank levers PP, jointed at their upper ends to the valve spindles NN, and at their lower ends to the catch rods CC.

FIG. 8.



HIGH-PRESSURE CYLINDER, 18½in. diameter, 5ft. stroke.
LOW-PRESSURE CYLINDER, 32¾in. diameter, 5ft. stroke.
TOTAL INDICATED HORSE POWER, 206.

The valves are actuated from a sliding box working in the guide frame K. This box receives its reciprocating motion from the forked eccentric rod B, and the upper side of it is provided with two grooves, which receive the right and left hand catch rods CC.

Steel notches EE are fitted at the bottom of each groove, which engage alternately with corresponding projections DD on the catch rods CC at the commencement of each stroke. As soon as this engagement takes place the corresponding expansion valve is raised, uncovering the grid apertures, which are kept open until the catch rod C is raised by one of the tappets F, and thus disengaged or released from the notch E.

The governor rod G is arranged midway of the stroke of the sliding box, and works in stationary guide bearings, in which it is free to move up and down according to the position of the governor. This governor rod is connected by arms or links HH to the lower ends of the tappet levers LL. When the engine is at rest the links HH are in a horizontal position, and the tappet arms wide apart, but as the speed of the engine increases the governor rod G is raised and the tappet levers drawn nearer together. Thus the position of the double joint on the governor rod, relatively to the positions of the ends of the tappet levers LL, determines the point of the stroke at which the expansion valve rods CC will be disengaged and the cut off effected.

Means are provided for shortening or lengthening the catch rods CC, governor rod G, and links HH, as may be required for purposes of adjustment. With this detaching valve gear and toggle-joint arrangement, the work thrown upon the governor is very light, and the conditions are thus most favourable to efficient regulation. The point of cut off ranges automatically from $\frac{1}{32}$ to $\frac{3}{4}$ of the piston stroke.

Fig. 7 illustrates a pair of diagrams taken from a high-speed horizontal condensing engine, built for a large Manchester firm, and fitted with this valve motion.

A continual variation of 50 per cent in the load is shown. This engine was tested as to its regulating capabilities by suddenly knocking off the whole of the load by means of a claw coupling in the second motion shaft, with the result that there was only an increase of three revolutions during the first minute. It will be observed that the expansion curves in the figures are rather high towards the termination of the stroke, but this was due to the presence of water in the cylinder and pipes, owing to their not being protected at the time with non-conducting composition. The engine, in fact, had only commenced running for the first time when the diagrams were taken.

Fig. 8 shows another set of diagrams taken from a horizontal compound condensing engine, the high-pressure cylinder of which is fitted with this automatic cut-off.

Messrs. Stevenson and Co. have built a number of engines fitted with this patent cut-off motion for eminent firms in various parts of the country, and the working of the apparatus has in practice proved to be extremely satisfactory and economical.

We may remark that in applying this gear to smaller-sized engines, the air cylinders are placed horizontally at the end of the valve chest, the spindles passing through parallel to the main valve spindle, and having attached to them plain flat cut-off plates, working over ports in a fixed anchor plate which lies on the back of the main valve.

LOCOMOTIVES FOR CANAL BOATS.

In our issue for June 1st we referred briefly to some experiments which were being conducted by the London and North-Western Railway Co., with a view to test the feasibility of towing canal boats with locomotives running on the towing path alongside the canal instead of with horses.

The experiments did not prove altogether satisfactory, and led to considerable oscillation and irregularity in the motion of the locomotives. Since then further experiments have been made, with the result that the company have now definitely abandoned the idea of employing locomotives for traction purposes in this way. The carrying out of the proposal would certainly have been a very costly undertaking, and it is very questionable whether any possible advantages would have been at all commensurate with the outlay.

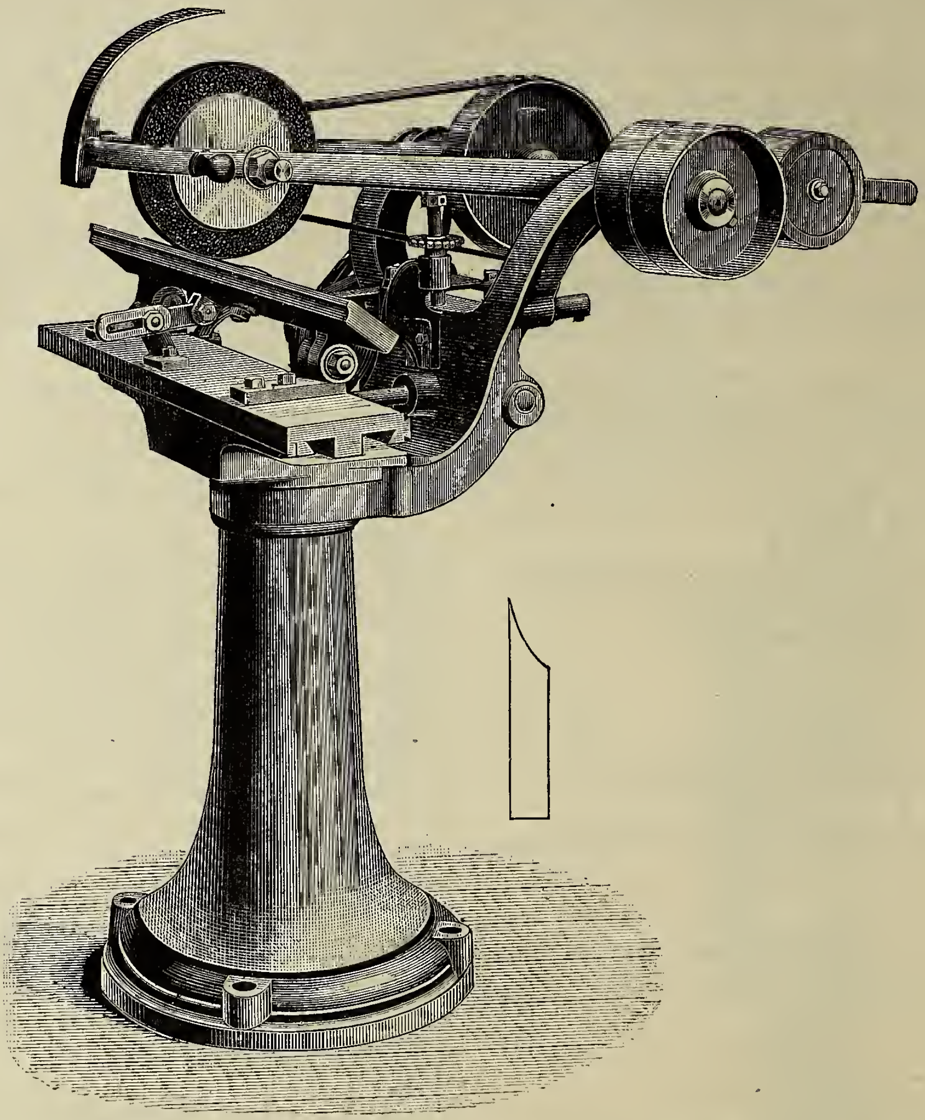
Its adoption would have involved the laying down of two sets of rails along the whole length of the canal, which would have also required deepening and its banks making stronger in order to withstand the wash from the boats, while considerable alterations would have been necessary to existing bridges.

The company's officials, however, are of opinion that steamboats may be adopted on the canal with advantage, and some small steel-plated vessels fitted with engines and boilers are being constructed for the purpose. These steamers will draw several barges, and although the present state of the canal is such that in many places only a very low rate of speed can be maintained, yet the saving of horse power and horse attendance will, it is estimated, form a considerable item in the more economical working of the canal.

The adoption of small steam-tugs for canal purposes is by no means new. A number of such vessels are at present employed on the Bridgewater Canal, and have been engaged in this service at least a quarter of a century. Their adoption has, we believe been found to be advantageous on the score both of convenience and economy.

Electric Tramway Series System.—An electrical tram way, on the series system, is now being constructed near Gravesend and will be working in December next. The system is based on the patents of the late Fleming Jenkin, Professors Ayrton and Perry, and others. The Series Electric Traction Syndicate claim to hold an absolute monopoly of series running for traction purposes.

PATENT SELF-ACTING KNIFE-GRINDING MACHINE.



The above illustration represents a compact and simple machine designed for grinding the edges of plane irons or knives of wood-working machines. The machine consists of a small emery wheel hung at one end of a balanced lever, as shown in the engraving, while the plane iron, or article to be ground, is bolted to a small inclined table which traverses to and fro at right angles to the plane of the wheel, and situated beneath it. The table can be readily tilted to any required inclination, and the cutting angle thereby regulated to a nicety. The motion of the sliding table is arranged so that it can be readily adjusted so as to give any required traverse. One advantage of grinding in this way is that the cutting edge is slightly concave or "hollow ground," the cutting edge being thereby retained for a longer time and much more readily touched up when required on a whetstone. The machines, which are constructed by Messrs. T. and R. Lees, Hollinwood, near Manchester, are made in several sizes, with strokes varying from 15in. to 20in. in length.

Further Bequests by the Whitworth Legatees.—The munificence of the legatees of the late Sir Joseph Whitworth appears almost as boundless as their catholicity. They have just offered to the authorities of Owens College, Manchester, a site for a general hospital where the medical students may receive practical instruction in medicine and surgery, and have further offered to give the sum of £35,000 towards its erection and furnishing, and to contribute £1,000 per annum to its maintenance.

THE SHIPMAN ENGINE.*

This motor is an automatic petroleum-burning steam engine, and has been designed by Mr. Shipman, of America, for use either on launches or in houses, where a moderate amount of power is required. One of its essential points is that it is automatic, so that when once steam has been generated in the boiler, practically no further attention is required beyond that of opening and shutting the steam valve whenever the engine is started or stopped, the fire, speed, and water-feed being so arranged as to attend to themselves.

The engine is simple or compound, as may be best suited to the work it has to perform, and is built upon the same frame as the boiler. This latter is composed of tubes about 18in. long, which are screwed into a flat oblong chamber at one end and closed at the other, and is fired externally.

Two small aspirators or atomisers, taking steam from the boiler, suck up the petroleum, which is used as fuel, from a chamber below, and drive it into the furnaces in the form of a fine spray. A couple of torches ignite this spray as it passes inwards, and the flames produced by its combustion rush round and among the boiler tubes. The amount of steam and petroleum that is used by the atomisers is regulated by a diaphragm connected to a valve in the steampipe that supplies them.

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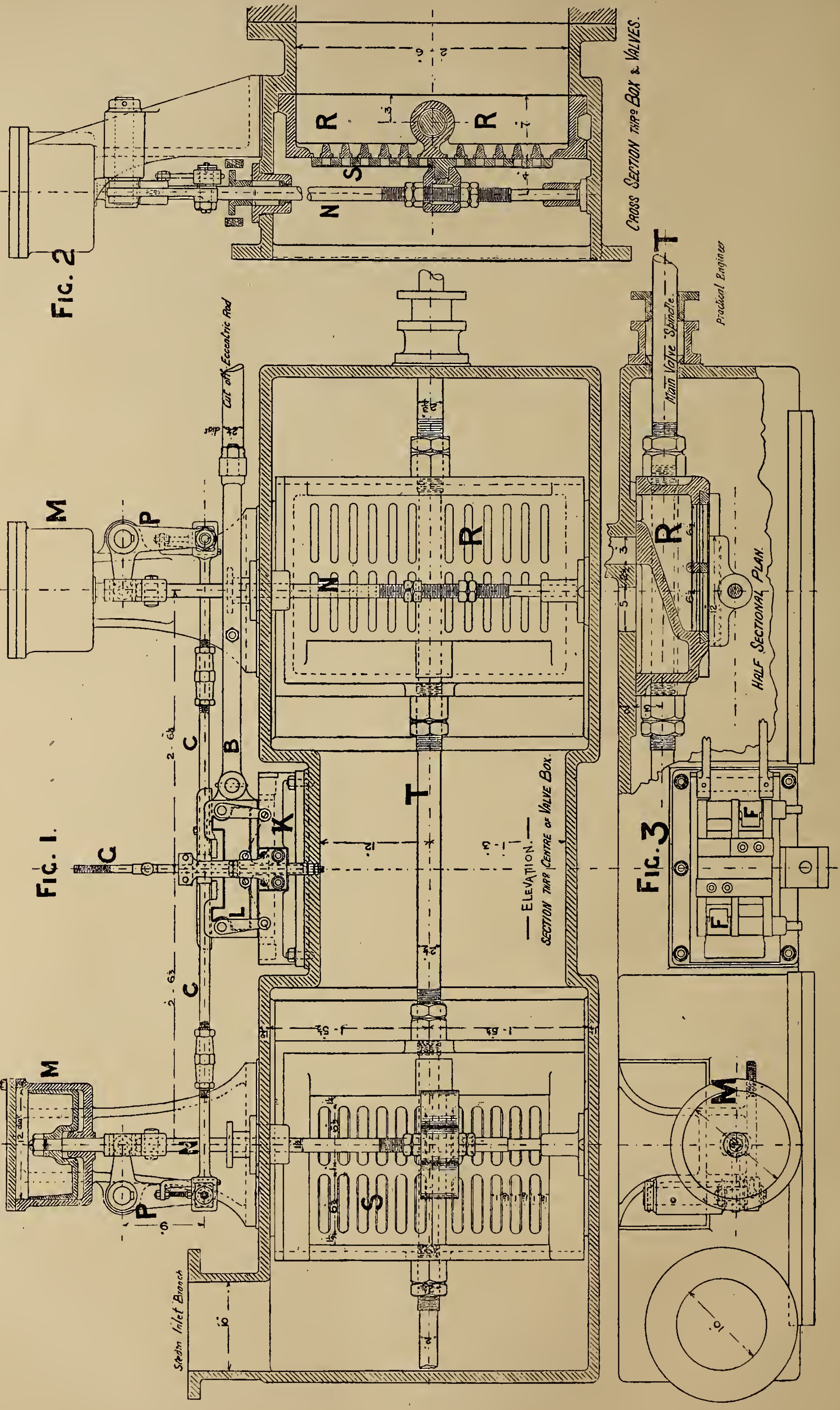
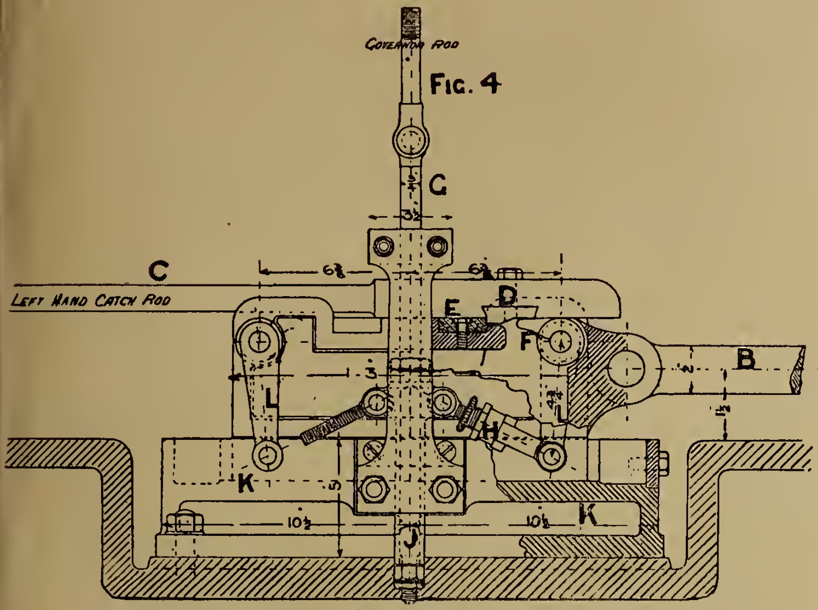
* Paper by W. R. Pidgeon, M.A., read before Section G of the British Association.

SECTIONAL VIEWS SHOWING GENERAL ARRANGEMENT OF VALVES AND TRIP-GEAR.



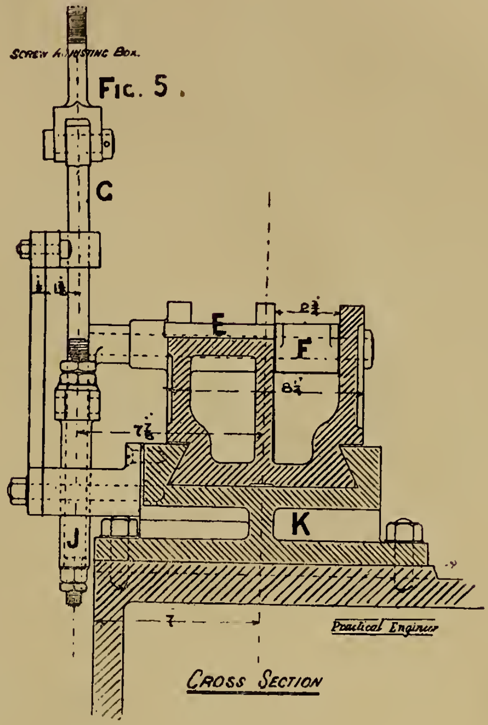
DETAILED VIEWS OF CAM BOX.

FIG. 4



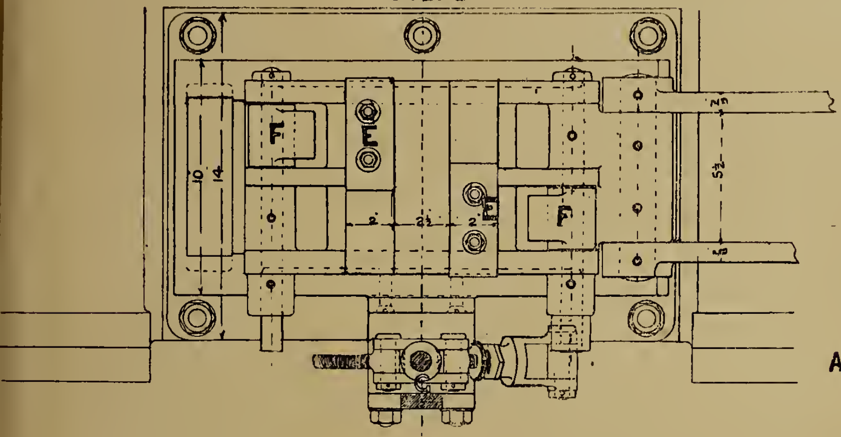
Half Sectional Elevation

FIG. 5



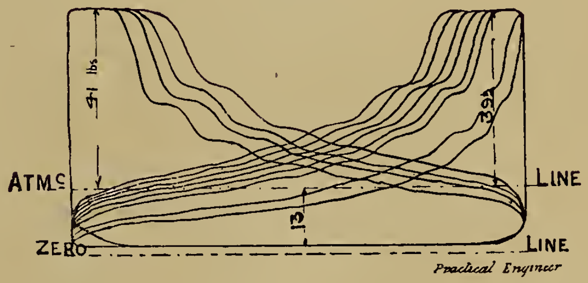
Cross Section

FIG. 6



Plan

FIG. 7



AUTOMATIC EXPANSION MOTION

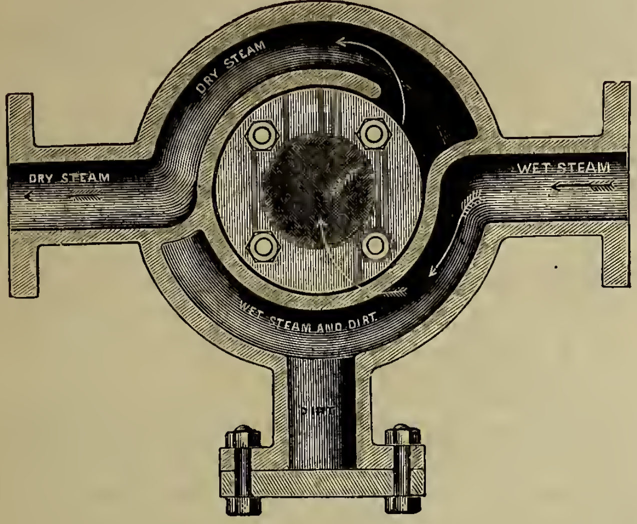
(Stevenson and Price's Patent),

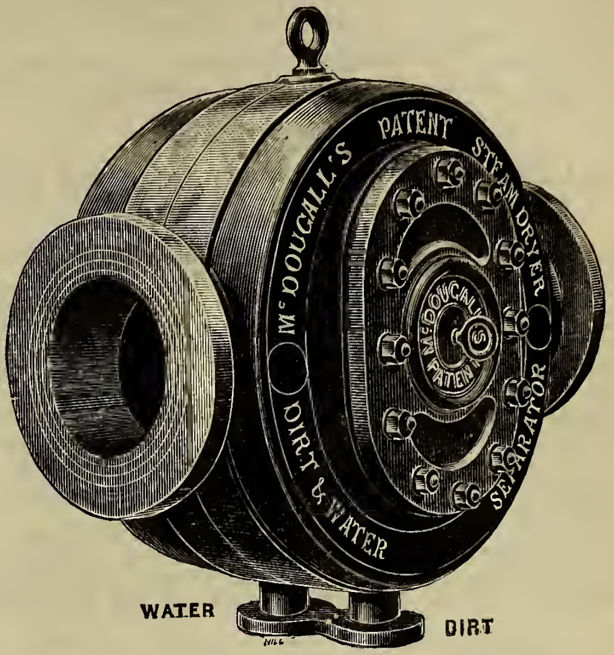
CONSTRUCTED BY

MESSRS. STEVENSON & CO., CANAL FOUNDRY, PRESTON.

(For description see page 485.)

McDOUGALL'S PATENT STEAM DRYER.





This diaphragm is exposed to the steam pressure on the one side, and is held down by a spring, loaded to a certain pressure, on the other, and moves upwards or downwards as the steam exerts more pressure than the spring, or *vice versâ*. Its movement is conveyed to the valve by means of a rod, and it thus regulates the amount of steam passing at any moment to the atomisers. In this way the fire is made to vary inversely as the pressure in the boiler, and thus keeps the latter constant.

The petroleum is stored in a tank at any convenient distance from the motor, and is led to it through a pipe having a regulating valve in it. The water in the boiler is kept at a constant level by means of a float, connected to a tap in the suction pipe in the pump. This float is placed in a chamber, which is joined to the top and bottom of the boiler, and rises or falls with the level of the water. The movement is conveyed, through a stuffing-box and by means of levers, to the tap in the suction pipe, which it opens or closes as the water level changes.

The speed of the engine is kept regular by means of a governor, which works directly on to the eccentric, and the lubricating of all journals, cylinders, and slides is performed by the ordinary sight-fed lubricators and cups, except that of the crank pin, which is effected by means of a centrifugal oiler attached to the crank disc. It may be seen from the foregoing that, when once steam is up, the fires, the water supply, the oiling, and speed of the engines require no further attention. But, when first starting, a sufficient pressure is required in the boiler to work the atomisers, and for this a hand air pump is provided. A few strokes of this pump will suffice to start the fires, and it is only necessary to pump slowly for five minutes to raise sufficient pressure of steam to keep them going, fifteen minutes in all being required to get steam up to 100lb. per square inch.

As regards the other requirements of small motors, the Shipman engine is compact, not heavy, and simple to understand, so that it neither requires much space, strong foundations, nor a skilled attendant. An engine developing 4½ H.P. on the brake uses 4·21lb. of petroleum per H.P.; and this at 7d. per gallon, would give the cost of running at under 3d. per brake H.P. per hour.

INTERNATIONAL TRADES UNION CONGRESS.—An international labour congress is to be held on November 6th and following days in St. Andrew's Hall, Oxford Street, London. The congress will be presided over by Mr. Shipton, and the official language will be French. A number of interesting subjects will be brought forward for discussion. The first subject for debate will be "The most efficacious means of removing the obstacles to free combination in foreign countries;" secondly, "The best methods of combination among the workers in various countries;" thirdly, "The limitation of production by reducing the hours of labour;" and fourthly, "The desirability or otherwise of State regulation of the hours of labour."

McDOUGALL S PATENT STEAM DRYER.

THE advantages of clean dry steam in its application to motive and manufacturing purposes are too manifest, both on the score of safety and economy, to require dilating upon. It frequently happens, however, that the arrangement of the steam pipes is such as to lead to a considerable amount of condensation between the boilers and the engines, or the boilers may be liable to priming, and thus carry over a considerable amount of dirt as well as water in suspension. To whatever cause the presence of water and dirt, however, may be due, their elimination, as we have already said, is desirable on every ground.

McDougall's patent steam dryer, of which we annex two illustrations—one giving a sectional and the other an external view—possesses several novel features, and has the advantage of being free from several objections which apply to some of the separators with which we are acquainted.

As will be seen from the sectional view, the separator consists of two annular chambers placed side by side, and connected by a central thoroughfare, over which is placed a wire gauze or netting, which acts as a kind of sieve, and prevents the passage of any dirt or sediment that may be held in suspension.

The steam, in the first instance, enters the front compartment, as indicated by the direction of the arrows, and then passes through the sieve referred to into the second compartment, whence it is drawn in a dry state ready for use. The sudden deflection of the steam from its course in the first chamber causes the greater portion of the moisture in the steam, as well as any sediment which may be held in suspension, to be precipitated in the first compartment, while the second chamber completes the separation of any moisture in the steam which has passed through the gauze.

The front chamber of the separator, in which dirt and sediment accumulates, is fitted with an outlet at the bottom as well as with a cover, so that the accumulated deposit may be cleared out when required. The second chamber is also fitted with an outlet at the bottom (shown in the external view), for the purpose of drawing off the water which accumulates. When possible, this water should, of course, be returned to the boiler, in order to avoid the loss of heat which would otherwise be involved in blowing it to waste. This result, of course, can only be attained when the separator is situated at a higher level than the boiler, and it is desirable in such cases to fix a check or non-return valve in the drain pipe near to the point where the water enters the boiler. When the arrangement of the steam pipes is such as to necessitate the separator being fixed at a lower level than the boiler, so that the condensed steam cannot be returned to it, the water may be automatically discharged by a steam trap or other suitable means.

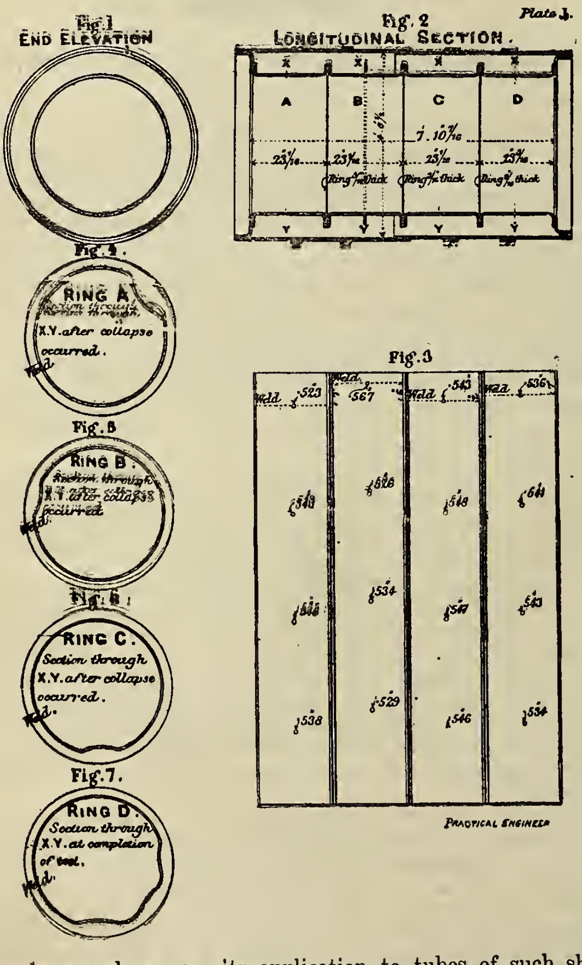
It will be evident that there is a wide field for the application of such an appliance as the one we have described, and its efficiency, coupled with its simplicity of construction and the efficient opportunities it affords for cleaning, will, we feel sure, secure its extensive adoption.

The makers of the apparatus, we ought to say, are Messrs. McDougall Brothers, Chadderton Ironworks, Middleton Junction, near Oldham.

INFLUENCE OF FLANGED SEAMS ON THE STRENGTH OF FURNACE TUBES.—I.

The question of the strength of furnace tubes is one on which much has been written at various times, and about which a considerable amount of speculation has been indulged in. Estimates with regard to the strength of long furnace tubes were, until comparatively recently, based almost entirely on the formula derived from the experiments conducted by Sir William Fairbairn. Careful observations, however, have shown that Fairbairn's formula can only be applied, with certain reservations, in the case of long tubes when new and in good condition, while its application to tubes that have been in work for a lengthened time gives results which differ very widely from the collapsing pressures recorded in the case of actual explosions.

To apply Fairbairn's formula to short furnace tubes, such as those of small vertical boilers and those in boilers of the marine type, is, as most engineers will be aware, altogether misleading; indeed it is but fair to say, that when Sir William Fairbairn's formula was drawn up its application to tubes of such short length was not contemplated and never intended.



In Fairbairn's formula the strength of a furnace tube to resist collapse is, other things being equal, taken to vary inversely as the length. One has only to consider the effect of this formula, however, on extremely long or extremely short tubes to realise that its application can only be legitimate within certain narrow limits.

The influence of length upon the resisting power of a furnace tube to collapse has been a vexed question amongst those who have to deal practically with the strength of such structures, and in our last issue we published a communication which had been addressed to a contemporary by Mr. D. K. Clark, dealing with the subject, and giving a formula for application to furnace tubes exceeding 10ft. in length, in which the element of length is altogether ignored. We have not space at present to deal with the basis on which Mr. Clark proceeds, and must content ourselves here with referring the reader to his communication.

Regarding the strength of short tubes engineers are largely indebted to experiments which have been conducted from time to time by the Marine Department of the Board of Trade, and several memoranda dealing with the experiments have been issued. The result of the tests that have been made seem to show that in the case of short tubes of plain construction, such as those met with in marine and small vertical boilers, the strength is fairly expressed by the following Board of Trade formula:—

$$P = \frac{C \times T^2}{(L + 1)\,D}$$

When P = collapsing pressure.
C = a constant dependent on the material and workmanship.
T = thickness of tube in inches.
D = diameter of tube in inches.
L = length in feet.

With the increase of pressure that has taken place in recent years, and the application of strengthening hoops of various kinds to furnace tubes, the question as to the precise influence of such appliances upon the ultimate resistance of the structure is one that has become of considerable importance, and the Board of Trade, which has hitherto displayed a very praiseworthy initiative in investigating these questions, has recently issued a memorandum to its surveyors, giving the details of some interesting experiments made a short time ago at the works of Messrs. James Howden and Co., Glasgow, with a view to ascertain the collapsing pressure of a furnace tube when strengthened with Adamson's flanged seams.

The good work which has been done by the Marine Department of the Board of Trade at various times, in placing upon a satisfactory scientific basis a number of doubtful points in boiler design, has, we think, scarcely been sufficiently appreciated, and its influence in promoting first-class scientific construction has been much greater than some engineers are disposed to admit.

The following is a copy of the official memorandum referred to, which, as the subject is of considerable practical importance, we print *in extenso*:—

Memorandum for the Information of the Board of Trade Surveyors.

Messrs. James Howden & Co.'s Experimental Furnace Tube.

Consultative Branch, Marine Department, Board of Trade,
Bedford Street, Covent Garden, London, W.C.,
12th December, 1887.

Sir,—I have the honour to inform you that I have witnessed the testing by hydraulic pressure of a new experimental furnace tube at the works of Messrs. James Howden & Co., engineers and boilermakers, Glasgow, and my report is as follows:—

The tube in question was intended to represent the furnace tubes of a modern high-pressure marine boiler, and was made of mild steel. The general arrangement of the tube and the cylinder in which it was tested is shown by figs. 1 and 2, Plate I., herewith.

Table I.

Distinguishing Letter on Ring.					
A.			B.		
Diameter (internal) at Mid-Length.		Length between Faces of Flanges.	Diameter (internal) at Mid-Length.		Length between Faces of Flanges.
Vertically.	Horizontally.		Vertically.	Horizontally.	
Inches. 41 15/16	Inches. 42 1/16 bare.	Inches. 23 1/16	Inches. 41 15/16 full.	Inches. 41 29/32	Inches. 23 1/16
C.			D.		
Inches. 41 15/16 full.	Inches. 41 15/16 full.	Inches. 23 1/16	Inches. 42 1/16	Inches 41 27/32	Inches. 23 3/16

The tube was practically 7ft. 9in. long over all, 3ft. 7in. diameter externally, and, as will be seen from fig. 2, Plate I., was made up of four rings or belts, nominally 23in. long by $\frac{17}{32}$in. thick, having flanged ends for attachment to each other, and, in the case of the outer rings, for attachment to the end plates of the testing cylinder. The flanges projected $2\frac{5}{8}$in. above the outer surface of the rings, and were about $\frac{1}{2}$in. thick. The radius of curvature at the root of each flange was about $\frac{5}{8}$in.

The rings were marked A, B, C, and D respectively, for reference, and were of the dimensions given in Table I.

(To be continued.)

DESCRIPTION OF THE COMPOUND STEAM TURBINE AND TURBO-ELECTRIC GENERATOR.*

The compound steam turbine has now been developed into a motor which utilises steam with a high degree of economy. It possesses considerable simplicity, and its speed of revolution is high; and as dynamos working at a high speed combine cheapness and efficiency, the application of the steam turbine for driving them is at first sight a good one. The combination of the steam turbine and dynamo has involved a considerable departure from existing practice, and has necessitated much experimental work and investigations on entirely new ground.

The first turbo-electric generator, completed about four years ago, ran at 18,000 revolutions per minute, and gave six electrical horse power; it has been in almost constant use since that time, and has done a large amount of work. The second, made shortly afterwards, runs at 10,000 revolutions per minute; it was placed on the Tyne Steam Shipping Co.'s steamer Earl Percy, and has worked her 60 lamps ever since to their entire satisfaction; the cost of fuel and maintenance is very small, and the light remarkably steady. Generators were then made for supplying up to 250 lamps, and a large number of installations were carried out, which have given excellent results; the consumption of steam was about equal to that of a good high-pressure engine with single slide when working with the same steam pressure and driving a good dynamo; but so marked has been the economy realised in regard to lamp renewals, oil, attendance, and other items, that the generators have almost, without exception given great satisfaction. It became essential, however, if these generators were to be successfully adopted for large installations, that higher degrees of economy should be realised, more nearly approaching those of the best compound engines. Theory, based on the authenticated performances of water turbines and the laws of the flow of steam and gases, showed that the turbo-electric generator possessed the elements of the highest economy, not merely comparable with the best known performances, but even superior to them. How far practice has come up to theory may be judged by the results given at the end of this paper, which it will be seen approach nearly the best results of ordinary engines working with the same steam pressures.

Compound Steam Turbine.—The compound steam turbine consists of two series of parallel-flow or Jonval turbines, set one after the other on the same spindle, so that each turbine takes steam from the one before, and passes it on to the one following. In this way the steam, entering all round the spindle from the central inlet, passes right and left through the whole of each series of turbines to the exhausts at each end. The steam expands as it loses pressure at each turbine; and by successive steps the turbines are increased in size or area of passage-way, so as to accommodate the increase of volume, and to maintain a suitable distribution of pressure and velocity throughout the whole series of turbines. The areas of the successive turbines are so arranged that the velocity of the flow of steam shall bear throughout the series about the same ratio to the speed of the blades; and as far as possible this ratio of velocity is so fixed as to give each turbine of the series its maximum efficiency. The two equal series of turbines on each side of the central steam inlet balance each other as regards any end pressure on the spindle of the motor, and thus remove any tendency to undue wear on the collars of the bearings.

Bearings.—As it is impossible to secure absolute accuracy of balance, the bearings are of special construction, so as to allow of a certain very small amount of lateral freedom. For this purpose the bearing is surrounded by two sets of steel washers of different diameters, the larger fitting close in the casing and clear of the bearing, and the smaller fitting close on the bearing and clear of the casing. These are arranged alternately, and are pressed together by a spiral spring. Consequently any lateral movement of the bearing causes them to slide mutually against one another, and by their friction to check or damp any vibrations that may be set up in the spindle. The tendency of the spindle is then to rotate about its axis of mass, or principal axis, as it is called; and the bearings are thereby relieved from excessive pressure, and the machine from undue vibration. The automatic oiling of the bearings almost entirely prevents friction and wear. The circulation is continuous, the oil being used over and over again; and as it deteriorates very slowly, and there is little waste, the consumption may be said to be unusually small.

Turbo-Electric Generator.—In a turbo generator of 25 H.P. actual all the turbines are of the same diameter, and the expansive action of the steam is utilised by varying the depth and pitch of the blades.

In the illustration of a 50 H.P. turbo generator, which may be said to be of the triple-expansion type, from the fact that it is made with three different diameters of turbines for the purpose of dealing more advantageously with the increasing volume of steam as it expands, the three barrels of different diameters contain the three successive sizes of turbines. In each barrel the blades are continuously varied in pitch, so that an almost perfect distribution of steam is attained; and each barrel by itself may be compared in some respects with a cylinder in a triple compound engine. In the larger sizes the blades are accurately curved, as in the best water turbines. To prevent end pressure the spaces at the ends of the corresponding barrels are connected by equalising passages.

Including fluid friction, the theoretical efficiency of each turbine in the set is about 89 per cent; and the mean efficiency of the whole set is theoretically about 87 per cent of the power which should be given out in the adiabatic expansion of the steam. At each turbine the flow of steam is continuous, and proceeds unchecked to the next. The steam expands slightly in passing each set of blades, but without shock and with gradually diminishing pressure, the whole energy of expansion being utilised to carry the steam through the subsequent turbines.

With the continuous lubrication and small pressure on the bearings, there is no material wear; and as the steam has no cutting action on the turbines, the initial clearances remain the same. Therefore the consumption of steam in the turbo motor does not increase under the conditions of every day running, and after long periods of work has been found to remain almost the same as on the trial run. The power absorbed in friction in the bearings has been estimated: when they are cold it is considerable, amounting to over one-third of a horse power per bearing; but when the oil becomes heated to its normal temperature, it falls to less than 20 per cent of this amount.

Dynamo.—The motor is coupled to the dynamo by a coupling socket with squared hole, which fits accurately upon the squared ends of the two spindles; this admits of the armature being easily withdrawn. The magnets are entirely of cast iron, and usually are made with simple shunt-winding only.

The armature is of the drum type. The body is built up of thin iron discs, insulated from each other by tracing paper; it is turned up, and grooves are milled out to receive the conducting wires. For pressures of from 60 to 80 volts there are usually thirty grooves.

The commutator is formed of rings of sections. Each section is formed of short lengths, and each length is dovetailed and interlocked between conical steel rings; the whole is insulated with asbestos, and when screwed up by the end nut forms with the steel bush a compact whole. There are fifteen sections in the commutator, and each coupling is connected to a section. The whole armature is bound entirely from end to end with pianoforte or brass wire.

Efficiency of Dynamo.—For a normal output of 400 ampères and 80 volts, the resistance of the armature from brush to brush is only 0·0025 ohm. The resistance of the field magnets is 23 ohms, or an electrical efficiency of just 98 per cent. There are losses due to eddy currents in the core and wire of the armature, and to magnetic retardation resulting from change of polarity of the core. These losses have been ascertained by separately exciting the magnets from another dynamo, and observing the change of steam pressure required to maintain the speed constant; the corresponding power was then calculated. The commercial efficiency of this dynamo has been found to be about 95 per cent.

Steam Consumption.—As the result of careful tests made when exhausting into the atmosphere and giving off 32,000 watts, the consumption of steam per electrical horse power has been found to be 42lb. with a steam pressure of 61lb. at the inlet; and

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* Paper read by the Hon. C. A. Parsons, before the Inst. Mech. Eng., Dublin, Aug., 1888.

35·1lb. with a steam pressure of 92lb. at the inlet. Tests made at Portsmouth Dockyard, and at Messrs. Weyher and Richmond's in Paris, have agreed closely with the tests made on the same turbo generators before they left the works at Gateshead. These tests have therefore confirmed the accuracy of the figures above given.

Advantages.—The characteristic advantages of the turbo-electric generator may be summed up as follows: Steadiness of the electric current produced, arising from the high speed and the momentum stored in the moving parts; freedom from accident, on account of simplicity and direct action; small first cost, and small cost of maintenance of machine and lamps; small consumption of oil; little attention required; small size and weight for the power developed, which is about nine watts per lb. of weight in the whole machine, including both engine and dynamo.

The number of these generators already supplied for ship and land installations represents an aggregate of more than 2,000 electrical horse power.

CORRESPONDENCE.

We do not hold ourselves responsible for the opinions of our Correspondents.

INCRUSTATION AND BOILER COMPOSITIONS.

To the Editor of "The Practical Engineer."

Sir,—The treatment of feed-water and the removal of incrustation is still, and probably ever will be, a knotty question. Many are the theories propounded, and numerous are the remedies offered to the public. There is perhaps no problem that has been so frequently attacked by boiler owners, composition makers, and others; and, whilst success has been attained in a few cases, there are many others in which the treatment adopted has proved to be positively harmful. If water requires treatment, it is better, if possible, to deal with it before it enters the boiler, and there are several successful processes in operation for accomplishing this. The cost of the plant, however, for outside treatment very often deters boiler owners from adopting it. If water is treated in the boiler itself, considerable care should be exercised, or the remedy may prove worse than the evil. If the water contains earthy matter, a simple process of filtering or settling is of great assistance, and frequent cleaning of the boiler may be all that is necessary. If the feed-water, however, contains lime or magnesia, the quantity of solid matter is not always an indication of its fitness or otherwise for boiler purposes. Sixty grains of earthy matter per gallon may be of less importance and more readily removed than, say, 25 grains of carbonate or sulphate of lime or magnesia.

There are boiler compositions in the market which have a good reputation, but these are few, while the name of the worthless is legion. Whatever the nature of the composition, experience has shown that it should be used in small doses if it is to prove satisfactory, and the use of the blow-out tap should not be neglected. Compositions which are recommended to be used in 5 cwt. doses, with an injunction that the blow-out tap is not to be opened, should be carefully avoided. The writer recently had such a case brought under his notice, where the adoption of such advice by the maker of the composition resulted in the furnaces being overheated and bulged out of shape the first time the boiler was set to work. As a record of this fact may be of advantage to other steam users in putting them on their guard against the blind acceptance of statements made by the makers of boiler compositions, I venture to crave a little of your valuable space. Personally I cannot but think that if steam users would more frequently spend a little money in increasing the salaries of boiler attendants, so as to secure better men and more efficient cleaning, the investment would, in the majority of cases, be found far more beneficial than the expenditure of a much greater sum in the majority of boiler compositions that are sold.

Yours truly, Scriber.

October 8th, 1888.

A RAILWAY HERO.

To the Editor of "The Practical Engineer."

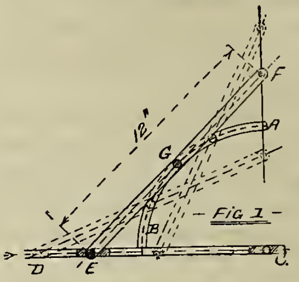
Sir,—Referring to the article with the above heading in your last week's issue, I beg to say that a parallel case to that of Anthony Thompson, mentioned in your paper, deserves to be remembered. I allude to Joseph Sieg, on one of the Southern railroads, U.S.A. It occurred, if I remember rightly, about three years ago, and happened in the same manner. Opening the fire-door, the back draught blew a sheet of flame on to Sieg and his fireman, severely scorching them, and forcing them to retreat along the platforms on the cars, at the same time firing the cab and store of wood. The whole footplate was speedily a regular furnace, fanned by the terrific speed of the train. Knowing that there was a train ahead, and the cars beginning to fire, Engineer Sieg returned to his engine and remained in the cab until he had brought the train to a stand, and then died in a few minutes. It need scarcely be pointed out that Sieg returned to *certain* death.

Govan, Oct. 9, 1888. G. T. P.

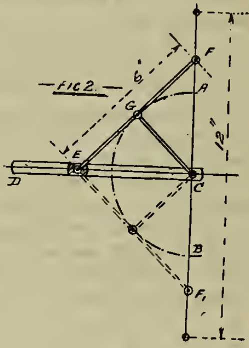
QUERIES AND REPLIES.

To Draw a Straight Line.—I am obliged to "Omicron" for his kind reply to my query *re* valve diagrams, in your issue of September 7th, and offer an apology for my omissions of the data mentioned. If not imposing too much on his good nature, may I invite his solution of the following query, taken from the Science and Art Examination Paper in *Steam* in 1886, viz.: "Arrange the dimensions of an instrument for giving a straight line path of 12 inches."—C. J.

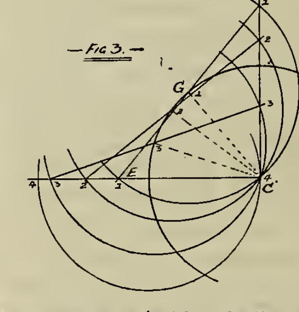
Answer.—In reply to the invitation of "C. J." with respect to a solution of his query on "straight line paths," I presume that the motion referred to is that of a true parallel motion, and I am of opinion that the most simple instrument that can be constructed for the purpose required is one identical in principle with that proposed by Mr Scott Russell, of which the following is a description of the instrument, together with a short explanation of the principle involved. Referring to fig. 1: A B is a circular groove struck to a radius A C from the centre C; D C is another groove, but perfectly straight, and horizontal in direction; E F is a straight bar, or link, whose length is equal to twice that of the radius C A, and in the middle of which is a pin G, constrained to move in the circular groove A B. The end E of this bar is also provided with a pin, so that it may slide truly along the groove C D. Now, on pushing the end E along the slot C D in the direction of the arrow, the end F will be found to describe a straight line at right angles to the groove C D, and further, if the end E be moved through the space of 12in. from C, the end F will be found to have traversed over a similar distance, down to C. From practical considerations, however, the following is a much more convenient form for the contrivance, when used as an adjunct to a steam engine, as the circular groove (shown in the former illustration) is a serious objection to its use, and in fig. 2 it will be seen that the pin G is connected with a radius bar or link C G turning on a fixed centre at C, and thus the pin G is forced to describe a circle round the centre C, thus doing away with the need of the circular slot or groove, as shown in fig. 1. The end E should work in a perfectly straight slot as before, if a perfectly straight line is required. The principle upon which the theory of the contrivance depends is, that the angle contained in a semicircle is a right angle; thus, no matter what position you ascribe the point G, a circle described with that point as centre and G C as radius will be found to pass through the three points E C F, as shown in fig. 3. In virtue also of this fact, Mr. Scott Russell proposed a modified construction for the same purpose. Thus, in fig. 4, at the point C, a swivelling circular slot is provided, in which a semicircular bar F E may slide. The end E is constrained to move as before in a straight slot D B. Then, on moving the end E along the slot D B, the other end F of the semicircular bar will be seen to describe as before the straight line K T. It follows that the minimum length of bar E F in fig. 1 necessary to draw a straight line 12in. long would be 12in, the length of radius of circular slot being half that amount, viz., 6in. In fig. 4, owing to the presence of the swivelling slot at the centre C, the diameter of the semicircular bar F E would require to be somewhat larger, as the point E cannot reach the centre C as it does in fig. 1; and it should be noted that for intermediate positions the amount of traverse x *is not* equal to that of y. A great deal more might be written on the subject, but I am afraid to trespass further on your space.—Omicron.



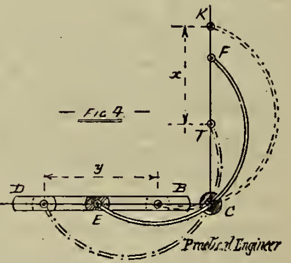
— Fig. 1 —



— Fig. 2. —



— Fig. 3. —



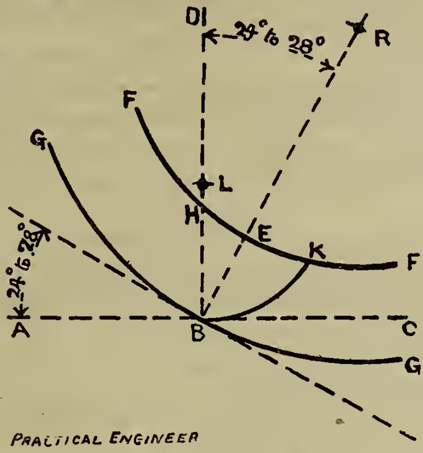
— Fig. 4. —

Horse Power of Lancashire Boiler.—I would esteem it a favour if you would give a rule which would enable me to find how many Lancashire boilers would be required to drive an engine of 288 indicated horse power, working high pressure?—John Dunlop.

Answer.—Like some others of our readers, you appear to be a little confused in your ideas regarding horse power of boilers, and speak of the boiler and the engine as if the two combined formed one motor. This is a common error, and leads to a great deal of confusion. It should be clearly understood, therefore, that the boiler is just as much a heat engine as the steam engine itself. The function of the boiler is to convert the heat of the coal into steam, and the function of the steam engine is to convert the heat of the steam into work, so that the I.H.P. a boiler will develop depends, to some extent, on the efficiency of the engine. The power of a boiler, therefore, should be measured by the weight of water it is capable of evaporating in a given time—say an hour. Turning to your question, we may remark, in the first place, that Lancashire boilers are not all made to one size. The most common diameters are 7ft., 7ft. 6in., and 8ft., the furnace tubes of which measure respectively 2ft. 9in., 3ft., and 3ft. 3in. in diameter. If we take, for the sake of illustration, the boiler 7ft. 6in. diameter (similar to the one illustrated in our issue of July 27th), and assume the firegrate to be 6ft. 6in. long, the total area of the grate is 39 square feet. Such a boiler, under favourable conditions, would burn about 20lb. of coal per square foot of grate per hour, and, with coal of fair quality, evaporate about 8lb. of water per pound of coal. The total weight of water evaporated, therefore, per hour may be taken as 39 × 20 × 8 = 6,240lb. The question then remains, what amount of indicated horse power does this represent? As we have already stated, this would depend entirely on the engine, whether it was well designed or badly designed; whether it was economical or extravagant. If, for the sake of illustration, we assume the engine consumes 20lb. of steam per I.H.P. per hour, then the 6,240lb. of steam would represent $\frac{6,240}{20} = 312$ I.H.P. Proceeding on the same basis, the 7ft. boiler, with grates 6ft. long, would represent 264 I.H.P., and the 8ft. boiler, with grates 7ft. long, 364 I.H.P. In practice it is found that large Lancashire boilers are, relatively speaking, more powerful than small ones, probably owing to the increased size of furnace permitting of a higher temperature, and, therefore, more rapid combustion. We have dealt with your query at considerable length, as it is one of a kind which is frequently coming before us, and about which many engineers appear to entertain very hazy notions.—Ed.

Floats for Ponclet Wheel.—I wish to replace the flat boards of an undershot water wheel, with the curved float board of a Ponclet reaction wheel. A plain practical rule for getting the proper curve will greatly oblige.—A Country Millwright.

Answer.—The following method of striking out the curve will probably be found very practical and effective: Draw AC and BD at right angles. Let BR equal radius of wheel, the divergence from the vertical varying from 24 deg. to 28 deg. according to height of fall. Take BE from one-third to one-fourth the height of the fall. Then with centre R describe the circles FF and GG, representing the inner and outer circumferences of the floats. Take HL equal to one one-sixth BH, and with L as centre and LB as radius describe the curve of the floats BK. The number of floats in a Ponclet wheel is generally greater than in ordinary undershot wheels. The following is a convenient rule with regard thereto:—



If d = diameter of wheel in feet, then for wheels from 10ft. to 20ft diameter number of floats = $\frac{8 \times d}{5} + 16$. Thus for a wheel 10ft. in diameter number of floats = $\frac{8 \times 10}{5} + 16 = 32$.—Ed.

Dip of Fault.—Would some of your able correspondents kindly explain to me what is meant by the "dip" of a fault? For instance, a fault is said to have a bearing of N. 45° W. and dips N.E. about 15in. per fathom. I understand all about the bearings of faults, but I am not quite clear about the dipping of them.—St. Luke.

Answer.—This is, properly speaking, the same as "dip" of mine, and in the case mentioned the fault would incline downwards towards the north-east, at the rate of 15in. perpendicularly to 6ft, horizontally. But probably the meaning is that it inclines downward at the rate of 6ft. vertically, for 15in. horizontally = about 12 deg. to the vertical. This is the "hade" of the fault; the "dip" would be 78 deg. I never saw a fault with so small an inclination as 12 deg. from the horizontal.—H.

Accidents to Marine Engines.—Will some correspondent tell me whether a book has recently been published dealing with accidents to marine engines at sea?

Answer.—We are not aware of any book that deals exclusively with accidents to marine engines. Most of the hand-books that are published touch more or less upon the subject, while you will find a considerable amount of practical information in the series of articles appearing in our pages entitled "An Engineer's Life at Sea."—Ed.

Relief Pipe on Hot Well of Marine Engines.—In steamships, a pipe is generally attached to the hot well, almost always as high as the engine room will allow, and brought down again to the bilges. Will some of your readers kindly explain the use of such, and the necessity for it being carried such a height? Why would it not do lower, or a relief valve supply its place.—D.P.

Answer.—The pipe is to allow for overflow should the feed pumps refuse to act. It is made high so as to allow a head of water to accumulate before overflowing, thus assisting the pumps. It is open to the atmosphere so as to discharge freely the air drawn from the condenser, and to allow the feed pumps to draw from atmospheric pressure, and not from a vacuum. If the pipe were lower, it would more readily overflow and cause needless waste of water. A relief valve, with any appreciable weight on it, would put back pressure on the air pump, and prevent free discharge of air and water, and if the valve were not loaded, its utility would not be obvious. A relief valve would also require a waste pipe to the bilges, as well as the present arrangement, besides introducing needless complication.—W. A. C.

Tanite Emery Wheels.—Can some reader furnish me with the address of the makers of tanite emery wheels?—E. C.

Answer.—The makers of the tanite emery wheels are the Tanite Co., Stroudsburg, Monroe Co., Pa., U.S.A., and we believe the wholesale agents for this country are Messrs. Selig, Sonnenthal, & Co., Queen Victoria Street, London, E.C.—Ed

Winch Barrels.—Many thanks to "W. A." for the formula regarding winch barrels. There is one thing I should like to ask, it is this: Is the thickness of metal of the barrel not taken into account? I think it ought to be. If "W. A." will kindly give me light upon this I shall be greatly obliged to him. Also, if possible, to give me a formula where the thickness of metal is taken into account.—Nimrod.

Answer.—As no mention was made by "Nimrod" of the thickness of metal in the winch barrel, it was assumed to be solid, as they are frequently made so; whereas if not solid but of uniform thickness of metal throughout its length. the following formula will apply:—

As before, let L = length in inches between the middle of the bearings
D = exterior diameter of barrel in inches
d = interior diameter of barrel in inches.

Then breaking weight in lbs. = $\frac{4460\,D^3}{L} \times \left(1 - \frac{d^4}{D^4}\right)$, of which, for safety, not more than one-eighth ought at any time to be applied. W. A.

Spiral Springs.—Referring to the formulæ that have already appeared in the query columns of *The Practical Engineer* with regard to this subject, I should esteem it a favour if your correspondent "W. A." would kindly give me the rule for spiral springs of *rectangular* section.—Scoto.

Answer.—In answer to "Scoto," the formula for one case of rectangular sectioned springs is given, that is when the section is square; but if the section be rectangular, and not square, let

D = diameter of spiral coil from centre of section to centre of section in inches
b = breadth of metal in the coil in a radial direction in inches
t = thickness of metal in the coils in inches
n = number of coils
E = extension or compression of the spring in inches
W = load in lbs. carried by the spring.

Then $$W = \frac{1704500\,E\,t\,b^3}{n\,D^3}$$ —W. A.

Helical Wheels.—Can any of my fellow-readers inform me of the best mode of setting out the teeth of a pair of bevel helical wheels, the larger wheel to be 34·8in. diameter, with 6in. face and 73 teeth, 1½in. pitch, and the smaller one or pinion 18·14in. diameter, with 6in. face and 38 teeth 1½in. pitch? Also a plain spur wheel 77·98in. diameter, with 140 teeth, 1¾in. pitch, to work in a pinion 40·1in. diameter, with 72 teeth. Any information with regard to making the patterns would oblige.—J. W. J.

Would some reader kindly inform me what is the proportionate strength of helical wheels in comparison with spur wheels having similar diameter, pitch, and face; also what is the rule for finding the breaking strength of helical wheels?—W. R. E.

Weighing Machines.—Is there any book published dealing specially with the construction of these machines, and what is the price?—T. D.

Chilled Furnace Bars.—Can any of your readers give me any information with regard to chilled furnace bars? To what depth can they be chilled from the top surface? Is it difficult to cast chilled bars any length—say 6ft.? What difference does it make in the nature, temperature of fusion, and also cost as compared with ordinary furnace bars?—Durability.

Olive Oils.—I should be pleased if any of your readers would furnish me with an easy method for testing the purity of olive oils.—M. Barker.

Hoppers for Grinding Mills.—Having a number of hoppers to make for a grinding mill, I shall be obliged if some reader would give me a rule other than rule of thumb for finding the proper bevil to plane the corners to.—A Country Millwright.

Roaring of Steam.—It often occurs that our engine is suddenly stopped, with good fires under boilers. After opening doors, &c., a 3in. valve on main steam pipes is opened to relieve pressure. This blows up through roof, and the roaring is rather an annoyance to the neighbourhood. Now, I should be glad of some plan for stopping this. I have heard that the roar may be completely deadened by blowing into a box filled with stones or broken glass. Can any reader say, from experience, that this is correct? I have also seen exhaust pipes of engines projecting through roofs fitted with a sort of inverted cone arrangement on the top. What is this for?- Fireman.

TO CORRESPONDENTS.

A. C. Beweis.—There are no examinations held with regard to the qualifications for engine attendants on land. With regard to what is necessary for the Board of Trade certificate for marine engineers, see answer under heading of "Marine Engineer," given on page 467 of our last issue.

G. H. Moodygunier.—The greatest amount of vacuum that we ever remember to have met with in an engine working under normal conditions, that is as shown on the indicator diagram, was 13lb. This, however, we should consider very exceptional, and look upon 12½lb. as being very good, and only attainable when the condition of the atmosphere is favourable, *i.e.*, when the barometer is high, or in other words, when the pressure of the atmosphere is great. Statements regarding excessive amount of vacuum should be received with suspicion, and should not be accepted without verification. Some attendants, we know from experience, are fond of displaying indicator cards, showing very fancy results in this direction, but we strongly suspect that a test of the indicator spring would reveal the cause of the abnormal result. It is the easiest thing in the world to file a little off the spring in order to make it weak, and thus give a false reading. We mention this in order to put you and others on their guard.

J. T.—The information you seek is so elementary that we hardly care to take up our space with an answer; at the same time, we never like to turn an applicant away empty handed. Briefly, the area of a circle is found by multiplying the square of the diameter by ·7854. If the diameter is taken in inches, the result will be expressed in square inches. The circumference of a circle is found by multiplying the diameter by 3·1416.

Rheea Fibre.—In answer to "T. H.," we believe the prizes offered by the Indian Government were withdrawn in consequence of the inability of the competitors to comply with the test. As we stated, however, trials are at present being conducted in Paris in connection with a prize which has been offered by the French Government. We don't know if it is now too late to enter, but you could probably obtain information by writing to the French Embassy in London. The sample of fibre enclosed with your letter certainly appears very satisfactory, and if, as you say, it can be produced at a less price than cotton, it should have a good future in store.

MISCELLANEA.

A New Train Signalling Invention.—It is stated that Charles P. Larned and R. V. R. Sill, of Detroit, have patented a means of signalling from one portion of a train to another with compressed air. The signal is made by liberating compressed air. It is said that the apparatus is so accurate that it can be used for sound telegraphy.

Overwork on Railways.—It is stated that the Board of Trade have ordered the principal railway companies to supply them with returns showing every occasion during two typical months this year and last on which any man concerned with the working of the traffic was on duty for more than 12 hours continuously. It is believed that the Government contemplate the introduction of a measure dealing with the subject.

The Ribble Navigation Scheme.—The Preston Town Council, after considerable discussion, have resolved to proceed with the scheme for improving the navigation of the Ribble, which was temporarily suspended by the decision of a Parliamentary Select Committee, and have decided to promote an application to Parliament for powers to borrow the requisite sums for completing the docks and works.

Electric Omnibuses.—The General Omnibus Company in Paris has introduced into its service the electricity supplied by the Electric Storage Company. The carriages run from the Arc de Triomphe to Courbevoie, a distance of about two miles. Each of the two fore-wheels is put into rotation by a separate dynamo, over which the driver exerts control. The velocity is somewhat greater than that obtained with horses.

The Iron Trade.—Sir Thomas Martineau, the president-arbitrator of the Midland Iron Trade Wages Board, has issued his award on the question lately raised by the ironworkers' application for the advance of 12½ per cent in wages. His award is to the effect that puddlers' wages, which govern those of other classes of operatives, shall be raised on and after the 20th inst. from 6s. 9d. to 7s. 3d. per ton. This is an advance of 6d., or nearly 7½ per cent. This new arrangement is subject to one month's notice on either side.

Locomotives for Heavy Inclines.—Some people have got rather mixed in their ideas of the new locomotives being sent out to work the heavy inclines on the Sind Peshin and Bolan Railways (says *Indian Engineering*). It would be but a poor performance for an engine weighing 128 tons to only take 70 tons up an incline of 1 in 15, but two miles long. Messrs. Neilson and Co. have sent out two different descriptions of engines for heavy inclines—one an eight-wheeled coupled tank engine with inside cylinders for Kojak works, weighing in steam 58 tons, and capable of taking a train of 70 tons, exclusive of engine, up inclines of 1 in 15. The other, a twin engine consisting of two separate six-wheeled coupled engines, with one tender between them, weighing in all 124 tons, from the designs of Mr. C. Sandiford, locomotive superintendent, N.W. Railway, Lahore, calculated to take a train weighing over 300 tons up long gradients of 1 in 40.

New Method of Procuring Aluminium.—In the *Comptes Rendus* Mr. G. A. Faurie gives the following method of procuring aluminium: Two parts of pure, finely powdered clay are mixed into a paste with one part mineral oil or other hydro-carbon. One part sulphuric acid is then added, and the mixture is carefully agitated until it becomes a uniform mass of a yellowish colour. Afterward the mass is heated in a crucible to a temperature of about 800° C. (1492° F.), until the decomposition of the hydro-carbon is complete, when it is allowed to cool. The obtained product is powdered and mixed with an equal weight of any metal dust. This mass is then heated to white heat in a closed graphite crucible. After cooling, a number of metal beads are found in the crucible, which are an alloy of aluminium and of the other metal used, out of which the aluminium can be easily separated. According to the inventor, the same method can be employed for separating silicon, calcium, magnesium, &c., from their oxides.

Refining Silver by Electricity.—The method of refining silver electrically, the details of which have been worked out by M. Moebius, is now coming into a somewhat extended use. It is most suitable for the refining of auriferous silver containing about 11 per cent of gold, the cost in this case being only about 7d. per lb. The principle on which the method is based consists in using in an ordinary electrolytic bath anodes of an argentiferous matte, and a thin plate of pure silver as the cathode. The bath consists of a very weak solution of nitric acid containing about one per cent of the acid. The anodes, which are about ½in. thick, with a surface of about 13·5 square inches, are placed in muslin bags which retain the gold, platinum, peroxide of lead, and similar foreign materials contained in the matte. The current used is 150 amperes, and the potential difference between the plates 1 volt. During the whole period of work brushes are kept moving up and down the silver plates, which sweep off the silver deposited into troughs put for the purpose at the bottom of the bath. These troughs are removed from time to time, and the silver taken out and sent to the furnace. If the matte contains copper, this is dissolved by the nitric acid, but is not deposited in the cathode.

SELECTED PATENTS.

APPLICATIONS FOR LETTERS PATENT.

June 5th.

8170a Electric Shunting Device, H. J. Allison, London. (The Baxter Electric Manufacturing and Motor Co., Incorporated, United States).—[Complete Specification.] Note: This application having been originally included in No. 8170, dated 5th June, 1888, takes, under patents rule 23, that date.

September 28th.

13951 Breaking, Screening, and Sorting Coal, the "Humboldt" Engineering Co., represented by W. E. Kochs, Cardiff.
13954 Electric Light Apparatus, S. Charlesworth and J. P. Hall, Manchester.
13960 Hoists, E. Chadwick, London.
13962 File-handle and File, T. H. Heard and W. K. Birkenshaw, Sheffield.
13963 Tubular Boilers, S. Saunders, London.—[Complete Specification.]
13970 Self-countersinking Screw, H. W. Bates, London.
13973 Weaving Smyrna, J. C. Newburn, London. (J. Lorthiois-Leurent and E. Malhere, France.)
13974 Dredgers, J. H. Wild and C. Cornes, London.
13978 Cutting Staves, J. Hawley, London.
13980 Spray Lamps, the Lucigen Light Co. Limited and G. Gerrard, London.
13983 Railway Interlocking Apparatus, C. Hodgson, London.
13984 Electric Accumulators, B. J. B. Mills, Middlesex. (J. Barbier, France.) [Complete Specification.]
13987 Electric Lighting, L. Saunderson, London.
13988 Pumping Engines, F. W. Walker, of the firm of Tannett, Walker, and Co., London.
13989 Box Nailing Machines, W. C. James and R. Mynard, London.
13991 Ores, J. C. Butterfield, Middlesex.
13992 Utilising Exhaust Steam, W. P. Thompson, Liverpool. (F. A. Tallendeau, France.)
13993 Engine Waste, J. H. Williams and M. W. Hydes, trading as Williams Brothers and Hydes, Liverpool.
13994 Safety Devices, J. Kendall and O. Cooper, London.

September 29th.

14000 Step and Bolster Bearings, S. Tweedale, Halifax.
14001 Cocks, W. Bradley, Sheffield.
14002 Steam Boilers, T. Wingate and L. Burnet, Glasgow.
14003 Dies, H. H. Forsyth, United States.—[Complete Specification.] Date applied for, under section 103 of the Patents, &c., Act, 1883, 19th June, 1888.
14006 Crane Buckets, J. Marshall, Glasgow.
14007 Chain, E. Baller, Birmingham.
14009 Printing Machine, W. Hayward, London.
14010 Measurements, E. Dejean, London,
14013 Pulley, T. O. Arnfield, Manchester.
14015 Sorting Tea, D. S. Sinclair, Glasgow. (J. E. Lyndall, India.)
14016 Grinding Mills, C. E. Hall, Sheffield.
14025 Engines, E. J. Millett, Manchester.
14032 Railway Door Locks, W. S. Lockhart, Middlesex.
14034 Safety Lift, C. W. Maclean, A. Wilson, and R. L. J. Ellery, London.
14038 Riveters, A. J. Boult, Middlesex. (V. Schönbach, Austria.)
14043 Lanterns, W. C. Hughes, London.
14049 Burners, R. Wallwork, of the firm of H. Wallwork and Co., and A. C. Wells, London.
14051 Refrigerating Apparatus, M. E. Douane and A. Jobin, London.
14055 Propelling Vessels, G. Lansell, London.
14056 Ships, G. Lansell, London.
14060 Pipe Connections, H. J. Pearson, London.

October 1st.

14068 Propeller Shafts, M. Immisch, London.
14071 Looms, J. Hunt and H. Heap, Halifax.
14076 Explosive Engines, H. A. Stuart and C. R. Binney, London.
14090 Electric Light Switches, H. C. Harold and R. Jenkins, London.
14094 Worm-gearing, C. L. Bath, London.
14095 Dynamo-electric Machines, J. Swinburne, Chelmsford.
14101 Cleansing Wool, I. Singer, London.
14104 Ventilating Appliances, E. Dickinson and F. J. A. Kindermann, London. [Complete Specification.]
14106 Steam Engines, H. Gourlay, London.
14107 Lead Pigments, J. W. Hall, London. (G. T. Lewis, United States).—[Complete Specification.]
14116 Steam Boilers, P. Hanrez, London.
14118 Rings and Springs, J. I. Hemmingway, Sheffield.

October 2nd.

14128 Bending Bars, L. Gathmann, London.—[Complete Specification.]
14130 Washers, H. H. Lake, London. (D. Dodd, United States.)—[Complete Specification.]
14133 Draught in Furnaces, H. H. Lake, London. (G. W. Brown and C. D. Mosher, United States.)—[Complete Specification.]
14137 Safety Catch, T. E. Bickle, Plymouth.
14142 Packings, J. Kirkman, Chorley.
14157 Covering Boilers, J. Grange, Bradford.
14162 Rolling Mill, F. H. Daniels, Middlesex.
14163 Wire Articles, H. A. Williams, London.—[Complete Specification.]

October 3rd.

14193 Valves, J. Horsfall, Halifax.
14196 Pipe Couplings, G. Wilson and G. F. Parkinson, London.
14200 Hydraulic Power, R. Middleton, Leeds.
14206 Cutting Laces, J. Blakey, Leeds.
14213 Valves, J. R. Fothergill, London.
14215 Nut-lock, T. B. Grant. Middlesex.
14216 Ball-bearing Governor, J. H. Dales, Leeds.
14221 Valve, F. A. Holleman, London.—[Complete Specification.]
14236 Steam Boilers, J. B. Prudhon, London.
14245 Tool Holders, J. W. Bishop, London,
14248 Gas Motor Engines, F. W. Crossley, H. P. Holt, and F. H. Anderson, London.

October 4th.

14255 Stud Links, R. J. Dawson and J. Beal, Sheffield.
14259 Doubling and Twisting Frames, M. Wright and E. Longbottom, Halifax.
14261 Gas Motor Engines, C. F. A. McAllen, Birmingham.
14264 Tube-cleaning Apparatus, E. S. Booth, Manchester.
14265 Heating Feed-water, A. MacLaine, Belfast.
14266 Oiling Gas Valves, A. Johnson, Gateshead-on-Tyne.
14278 Tubes, W. Pilkington, C. T. Bishop, and A. Brownsword, London.
14279 Cocks, A. Bonnefond, London.
14287 Alloying Iron and Steel, L. Q. Brin, London.

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Numerous complaints having been made to us by Subscribers of the difficulty they experience in obtaining copies of the *Practical Engineer* in certain districts, we have to state that the Journal can be obtained by any Newsagent through the ordinary trade channels, and no difficulty should therefore exist in obtaining copies by order of any Newsagent.

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EDITORIAL NOTICES.

All communications for the Editor of this Journal should be addressed to 6, Victoria Station Approach, Manchester.

Communications intended for insertion in the current week's issue should reach us not later than Tuesday Evening.

We cannot undertake to return rejected manuscripts or drawings unless accompanied by a stamped and directed envelope.

Contributors are requested to write on one side only of the paper. Sketches should be sent on separate sheets.

TO ADVERTISERS.

Advertisements intended for insertion in the current issue should reach us on Wednesday morning at the latest.

THE
PRACTICAL ENGINEER.
OCTOBER 19TH, 1888.

ALUMINIUM.

The utility of aluminium to the engineer is such that the excessive cost of its extraction alone has prevented its general use as an alloy with copper and other metals. The present generation has witnessed very rapid advances in the science of metallurgy, but these advances are, we think, only indicative of greater discoveries in the immediate future. If we only now allude to the profitable extraction of the metal aluminium and the undoubted beneficial influence of silicon and manganese, it is clear that we touch on a wide field, the boundaries of which it is not possible at present to reach. We will present our readers just now with a brief account of what is being done in the extraction and application of aluminium.

Aluminium is serviceable, first as a pure metal, and second as an alloy—chiefly as the latter. Quite recently two companies have brought into full operation processes for making pure and, alloyed aluminium. The first is the Aluminium Company Limited, having works at Oldbury, near Birmingham, for the manufacture of pure aluminium; the second is the Cowles Syndicate Company, near Stoke-on-Trent, for the manufacture of aluminium alloys.

In the first case the "Castner" process is employed, three stages being requisite for the extraction of the metal, comprising (1) the manufacture of sodium, (2) the manufacture of a double chloride of sodium and aluminium, (3) the reduction of aluminium. The sodium is manufactured by distillation from a mixture of caustic soda and a carbide of iron; the latter being prepared by mixing carbon and finely divided iron, which is then fused and broken up. The distilled sodium is condensed and stored under mineral oil; iron and carbonate of soda being left in the pits.

The double chloride of sodium and aluminium is produced by passing chlorine over a mixture of alumina, carbon, and salt, ground up together, and enclosed in heated retorts. The hot carbon unites with the oxygen of the alumina, forming carbon dioxide, which escapes, and the chlorine takes the place of the oxygen. The third stage is the fusion of the metallic sodium with the double chloride of aluminium and sodium; the chlorine leaving the aluminium for the sodium, the product being pure aluminium and common salt. The company's plant will produce from 400lb. to 500lb. of aluminium each working day.

The "Cowles" process deals at present only with the production of aluminium alloys. It had its origin in the impossibility of reducing the ores of aluminium at the temperature of ordinary furnaces. The Cowles furnaces are rectangular pits of fire-clay, arranged in series, each furnace being provided at each end with an inclined cast-iron pipe, within which the ore is reduced. An enormous dynamo supplies the electric current necessary for fusion. The current passes along two copper bars arranged above the furnaces, and connection is made between these and the furnace by means of flexible cables, attached at the lower end to copper bars, each furnace having its copper bar projecting within the cast-iron pipe just named. To the opposite end of each bar is connected its electrode. The electrode within each furnace consists of a bundle of carbons, to which a cylindrical head of metal is cast (iron for ferro aluminium, copper for aluminium bronze). The furnaces are charged with ore, metal, and charcoal (lime being mixed with the charcoal to localise the intense heat and to prevent fusion of the materials of which the furnace is composed). The gases generated escape through a hole in the cover of the furnace, and are burned; the aluminium and alloying metal are first volatised, and, ascending through the cooler layers of charcoal, are condensed and run to the bottom of the furnace. In about one and a half hours the "run" is finished, and the furnace left to cool, while another is being operated. The resulting alloys contain from 15 to 17 per cent of aluminium. To produce the commercial grades required the first product is re-melted with sufficient metal to give the required percentage alloys.

The beneficial effects of intermixture of aluminium with copper for the formation of various aluminium alloys is pretty well known, as also of its use in rendering fluid the metal for Mitis castings, and the imparting homogeneity to steel. Quite recently some very remarkable results have been obtained by Mr. Keep, of Michigan, U.S.A., by the admixture of small quantities of aluminium with cast iron. These, taken into conjunction with the other facts already known in relation to the beneficial influence of aluminium when alloyed with other metals, and with the recent introduction of the Castner and Cowles processes, will probably have the effect of giving additional impetus to the cheap extraction of that metal.

Mr. Keep's experiments embraced all the points by which founders are accustomed to estimate the value of a foundry iron, such as strength, homogeneity, chilling, shrinkage, fluidity, and so forth. We will rapidly summarise these matters as follows: The addition of ·01 per cent of aluminium to a white iron, which cast alone would almost certainly be very full of blowholes, had the effect of rendering it solid, with an increase of strength of as much as 44 per cent, to resist a dead load.

The beneficial effect of the aluminium is also apparent in metal repeatedly melted, effectually dispelling the idea that the aluminium does not remain in the metal.

Considered in relation to carbon, the effect of aluminium is very much like that of silicon—that is, it liberates carbon from the combined condition, causing it to become deposited as graphite. As this appears to happen at the moment of crystallisation, the result is that the graphite is distributed equally through the mass, so that the thinnest portions of the casting are as grey as the heavier. Thus, with a white iron full of blow holes, the addition of "three-fourths of 1 per cent" of aluminium produces an entirely grey iron, homogeneous throughout. Moreover, the effect of the dropping of the graphite at the moment of crystallisation is to protect the surface of the casting with a film of plumbago, to the prevention of sand burning and surface chilling, and this causes therefore the iron to be soft and easily tooled. Further, as grey iron shrinks only about one-half, or even less, than the white iron, this diminution of shrinkage is a distinct advantage, because the less shrinkage the smaller the internal stresses due to contraction. The fluidity of white iron is increased by the addition of aluminium, while elasticity of the metal is improved and the permanent set diminished, matters of much importance in structural castings. We shall, in view of these recent developments and discoveries, watch the growth of the aluminium industry with much interest, believing that it has a future second only perhaps to that of the steels.

POLYTECHNIC INSTITUTES FOR LONDON.—PRINCELY GIFT BY THE GOLDSMITHS' COMPANY.

Our readers will remember that a short time ago we referred to the generous offer which had been made by the Charity Commissioners of a sum of £150,000 towards the endowment and support of several polytechnic institutes for South London. This offer was made conditional upon a sum of equal amount being contributed by voluntary effort towards the object in view. We have now to announce an act of princely generosity on the part of the Goldsmiths' Company. This City Guild has just resolved to contribute an endowment out of their corporate funds of no less than £2,500 per annum towards the maintenance of a Polytechnic Institute, to be established at New Cross on the site now occupied by the Royal Naval School. Negotiations for the purchase of the site and buildings, with seven acres of land, have been successfully concluded, and the Charity Commissioners have agreed to set apart an endowment of similar amount for the same object.

The munificence of the Goldsmiths' Company will be more adequately realised if we state that it represents a capital sum of no less than £85,000, and this sum, it should be explained, has been bequeathed not out of trust funds, but from moneys over which the company has absolute control.

We are glad to be able to record an act of such conspicuous liberality and public spirit on the part of the Goldsmiths' Company. The immeasurable influence for good which the city guilds would be capable of exercising only those who are aware of the enormous funds at their disposal can fully realise. Their action in the past cannot be said to have been altogether satisfactory or measured by the liberality their friends could have wished. We venture to think, however, that if the rivalry in public works which now appears to be marking the action of the Goldsmiths', the Drapers', the Clothworkers', and one or two other companies, is taken up by the city guilds generally, very few persons indeed will be found to advocate the suppression of the companies, or to advise the curtailment of their liberties in any way. They constitute a picturesque survival of the ancient civic life of London, and it is far better that any reforms which may be necessary to bring them more in touch with modern surroundings should emanate from within rather than from without.

BOILER EXPLOSIONS.

(*Continued from page 459.*)

The following is a continuation of the reference to the Board of Trade Reports on Boiler Explosions, given on page 459 in our issue of September 28.

A Case of Priming.

Report No. 274. This case, like several others we have alluded to, is almost too trivial to be worthy of notice, and certainly does not, in our opinion, justify the Board of Trade in going to the trouble of issuing a report. The casualty to which it refers arose from the blowing off of a safety valve from its seat in consequence of the boiler priming, the priming being brought about by the attendant getting up steam with the water at too high a level in the boiler. We only refer to this case in order to make our reference to these reports consecutive, and think the department would exercise a wise discretion in refraining to issue reports dealing with casualties of such a simple character.

Failure of a Howard Boiler.

Report No. 275 refers to the failure of one of the pipes of a "Howard" safety boiler at the Tyne Shipbuilding Company's Works, on the 5th of June last. The explosion was due to the corrosion of the threads of the nipple which united the tube which gave way to one of the vertical tubes. The report states that the thread was so much wasted as to be of no practical use, and the failure appears to have occurred at the ordinary working pressure. No one was injured by the explosion, and the damage done was extremely trifling. From the report, it appears that the boiler was insured with the Boiler Insurance and Steam Power Company, and was tested about twelve months ago by hydraulic pressure by one of the company's inspectors to 112lb. on the square inch. The defect, however, does not appear to have been one which could have been discovered by inspection, and is mainly attributable to the defective design of the boiler, which is a type of which several explosions have been recorded, though it is now happily nearly extinct.

Vertical Boiler: Collapse of Firebox.

Report No. 276 refers to the explosion of a small vertical boiler at Farnhill, in Yorkshire, on June 14th. The boiler measured 8ft. in height by 3ft. diameter in the shell, and 2ft. 6in. in the firebox, which was made of three plates, lap jointed and single riveted, and originally $\frac{5}{16}$in. thick, but reduced by corrosion till it was little more than $\frac{3}{16}$in. It was furnished with the usual complement of fittings, including a glass water gauge, a dial pressure gauge graduated to 60lb., and a safety valve of enclosed construction, loaded by a lever and weight. As is almost invariably the case with these small vertical boilers, the explosion arose from the collapse of the internal firebox, some portions of which were blown completely out. The reaction of the issuing steam and water projected the boiler to a considerable altitude, and it fell in a wood-yard a short distance away, though fortunately without injuring anyone.

The report states that the firebox was so wasted by corrosion, that it could not be regarded as safe at a pressure of 60lb. on the inch, which was the point to which the safety valve was supposed to be loaded, while the Board of Trade surveyor remarks that on examining the safety valve after the explosion, he found the spindle set fast in the cover, so that the valve was perfectly useless. As the engine was stopped at the time, and there was a good fire burning, it is not a matter of surprise that the pressure soon accumulated until it became greater than the firebox in its weakened state could resist, and hence the collapse.

The boiler was not enrolled with any assurance or inspection society, and does not appear to have been examined by any competent person since it was laid down, fourteen years ago.

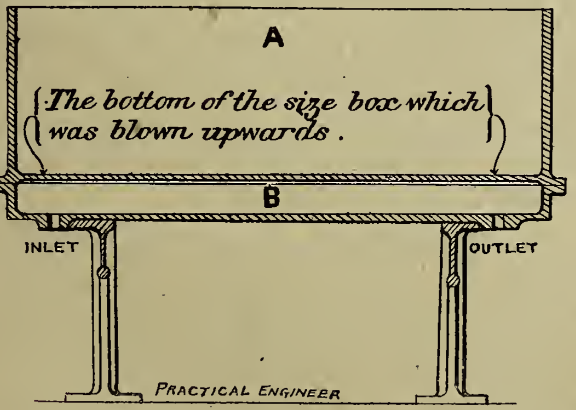
As the report points out, this case well illustrates the unsatisfactory manner in which many of these small boilers are worked, often with very indifferent attention, and with important fittings, such as the safety valve and pressure gauge, in such a condition as to be practically useless for the purpose for which they are designed.

Failure of a Water-gauge Connection.

Report No. 277 is another case which, to our minds, appears too trivial to warrant the issue of a report, although we are far from under-estimating the serious results which may, under certain conditions, attend comparatively slight failures of machinery on board ship. The casualty, or rather defect to which the report refers, consisted of the fracture of the small pipe connecting the upper end of the gauge glass column with the front end of a marine boiler, and if such little failures are to be characterised as explosions, then we ought to be favoured with an official report every time a gauge glass breaks or a fusible plug melts.

Bursting of a Size-melting Pan.

Report No. 278 refers to the bursting of a size-melting pan at the Heap Bridge Woollen Mills, Bury, Lancashire. The pan was a rectangular-shaped cast-iron box, measuring about 3ft. in length, by 17in. in breadth and 12in. in depth. The thickness of the metal forming the sides and ends was about $\frac{7}{16}$in., while that of the bottom varied from about $\frac{1}{4}$in. to $\frac{1}{2}$in. Bolted underneath the box was a second flat chamber about 2in. deep, which formed a kind of jacket, into which live steam was admitted for the purpose of boiling the size in the pan.



The steam was obtained from the boilers, which were loaded to 75lb. on the inch, but the supply to the pans was regulated by means of taps placed on the inlet and outlet pipes. There was no reducing valve, however, or safety valve, and thus nothing to prevent the full boiler pressure from being admitted into the steam jacket if the outlet tap were closed, while further, as there was no steam gauge, there was nothing whatever to guide the attendant in regulating the pressure.

The explosion arose from the rupture of the flat bottom of the pan, which was blown out and broke into several pieces, and caused slight injury to a workman who was standing near. Considering the structural weakness of the pan, and the absence of any means for controlling the pressure, the failure of the vessel can hardly be considered a matter for surprise. The report states that, in refitting the pan after the explosion, a safety valve was applied, so as to prevent the pressure accumulating beyond 7lb. on the inch.

In order that such vessels may be safely worked, it is necessary, as we have already pointed out in other cases, that they should either be made sufficiently strong or suitable precautions taken to prevent the pressure in any case rising above the load they are calculated to bear with safety.

Failure of a Flat End Plate through Grooving.

Report No. 279 refers to the explosion of a small flat-ended externally fired boiler, at Bradford, on June 22nd. The boiler measured about 9ft. in length by 2ft. in diameter, and $\frac{5}{16}$in. in thickness in the cylindrical shell. The flat end plates were each about $\frac{1}{2}$in. thick, and flanged at their attachment to the shell. The flanging had been effected by hand, and the flange was bent to a very sharp radius. This, coupled with the bellowsing action set up in the end plate by the varying pressure of steam, had led to the formation of a groove at the root of the flange of the front end plate, which had gradually extended until the end plate was eaten almost completely through for a considerable portion of the circumference, and became at length so weak as to be quite unable to resist the ordinary pressure of 35lb. on the inch.

From the evidence elicited at the inquiry the owner of the boiler, who was a hay and straw dealer in a small way of business, appears to have displayed great ignorance of the treatment necessary for the safe management of a boiler. Although he had worked it for twelve years, he stated that he had never examined or cleaned it, and, in fact, had not even taken off the manhole cover once during the whole of that period.

Explosion of a Tug Boiler.

Report No. 280 deals with the bursting of the boiler of a steam tug, while lying in the river Tees, at Middlesbrough, on the 16th of June. The boiler was of the return flue type, generally used in paddle tug boats in the district, and the explosion arose from the rupture of the outer shell, which was torn in several pieces.

The report states that the explosion occurred in consequence of the inability of the boiler to withstand the pressure at which it was worked, and the primary rupture is stated to have commenced in an old plate, $\frac{1}{4}$in. thick, where it was joined to a new one, $\frac{3}{8}$in. The shell of the boiler was, roughly speaking, of oval shape, and the Board of Trade surveyor states that from the appearance of the plate it was evident that a panting action had been going on for some time at the part where the primary rupture occurred.

The tug, as well as the boiler, is the property of the River Tees Conservancy, and the Board of Trade surveyor comments rather strongly on the ignorance displayed by the servants of the company responsible for the safe keeping of the boiler. Considering the fact that the Conservancy Commissioners retain the services of a chief-consulting civil engineer, a resident civil engineer, a mechanical managing engineer, and a foreman boiler maker, it certainly does seem surprising that the boiler should have been allowed to fall into such a defective condition and worked at a pressure for which it was evidently totally unfit.

THE INSTITUTION OF CIVIL ENGINEERS.

The Council of the Institution of Civil Engineers invites original communications on the subjects included in the following list, as well as on any other questions of professional interest. This list is to be taken merely as suggestive, and not in any sense as exhaustive. For approved papers the council has the power to award premiums, arising out of special funds bequeathed for the purpose.

The council will not make any award unless a communication of adequate merit is received, but will give more than one premium if there are several deserving memoirs on the same subject. In the adjudication of the premiums no distinction will be made between essays received from members of the institution or strangers, whether natives or foreigners.

List.

1. The utilisation of unused sources of power in Nature—such as the tides, the radiant heat of the sun, &c.
2. Standard specifications for the materials used in the construction of engineering works.
3. The influence of sea-water upon Portland cement mortar and concrete.

4. The construction, ventilation, and working of railway tunnels o great length.

5. Description of any new or peculiar type of mountain railway for very steep gradients.

6. Recent improvements in cable tramways.

7. The value, with respect to the safety and durability of metallic bridges, of (*a*) increase in the weight of the structure, by the choice of other than the lightest design; (*b*) increase in the dead load, by the adoption of a heavy description of flooring, with or without the addition of concrete or ballast.

8. The painting and preservation of metals, woods, &c.

9. Recent examples of hydraulic-lift graving docks.

10. Forms and construction of masonry dams for reservoirs.

11. The cleaning and deepening of drainage and irrigation canals by mechanical means.

12. On the sale of water by measure.

13. Descriptions of mining machinery of improved design.

14. Gold quartz reduction and amalgamation — description of the various machines, and of their method of working.

15. The physical properties of metals under test.

16. The working strength of iron and steel as affected by (*a*) the amplitude; (*b*) the frequency; and (*c*) the time-rate of the stress variations.

17. The present position of the manufacture of steel—its defects, and suggestions for its improvement.

18. The effect upon Basic steel of (*a*) chromium; (*b*) aluminium; and (*c*) tungsten.

19. The properties of bronzes and other alloys.

20. Researches on the actual working limits of stress in machinery or structures under known conditions of variation of loading.

21. The corrosion of metal structures, and the best means of preserving them.

22. The effect of wind upon structures, as influenced by (*a*) their superficial area; (*b*) the form or position of the exposed surfaces; (*c*) the shelter of adjacent bodies; and (*d*) the dynamic action of sudden gusts.

23. On forging by hydraulic pressure, and casting under the same.

24. The construction of the working parts of steam engines, in relation to the high pressures and temperatures now becoming general.

25. The practical limit to the working pressure of steam in marine boilers.

26. The various systems of forced draught in boilers, with the economical results obtained.

27. The most recent types of (*a*) mail steamers; (*b*) cargo steamers; and (*c*) warships.

28. On modern experience in screw propulsion, comprising the comparative efficiency of propellers of large diameter, and of smaller ones deeply immersed, and of the influence of form.

29. On the highest speeds attained and attainable on railways, having reference to gradients, curves, and the locomotives employed.

30. The application of the compound principle to locomotive and to portable engines.

31. Mechanical traction on common roads.

32. The petroleum engine and its applications.

33. The distribution of power by compressed air or by vacuum, and the construction of machines to be worked by compressed air or by vacuum.

34. Hydraulic rotative motors for high pressures.

35. The means of governing and economising high-pressure fluid in hydraulic cranes, engines, &c.

36. The construction and working of windmills suitable for raising water for the supply of villages and isolated houses.

37. The best combined system of warming, ventilating, and lighting large buildings.

38. The transmission of steam underground in the United States, with the results obtained.

39. The plant used in the execution of important engineering works.

40. Tools used in the building of iron and steel ships, and in the construction of boilers.

41. The construction and working of friction-brake dynamometers.

42. Steam cultivation by digging and by ploughing.

43. The generation of alternating currents in dynamo-electric machines, and their utilisation for lighting and power purposes.

44. Electric meters for recording the consumption of electrical energy.

45. The construction and maintenance of secondary batteries.

46. Central station electric lighting.

47. The application of electricity to the working of street tramways and of railways.

48. The application of electricity to the working of cranes, pumps, tools, &c.

49. The application of electricity to smelting and metallurgical operations.

50. The application of electricity to the purification of water and of sewage.

51. The purification of copper, and the reduction of copper ores by electrolytic processes.

52. Contributions to the bibliography of special branches of engineering.

In writing these essays the use of the first person should be avoided. They should be legibly transcribed on foolscap paper, on one side only, leaving a margin on the left side, in order that the sheets may be bound. Every paper must be prefaced by an abstract of its contents not exceeding 1,500 words in length.

Illustrations, when necessary, should be drawn on tracing paper, to as small a scale as is consistent with distinctness, but in no case should any figure exceed 6½in. in height. When an illustrated communication is accepted for reading, a series of diagrams will be required, sufficiently large and boldly coloured to be clearly visible at a distance of 60ft. These diagrams will be returned.

Papers which have been read at the meetings of other societies, or have been published, cannot be read at a meeting of the institution, nor be admitted in competition for the premiums.

The communications must be forwarded to the Secretary of the institution, from whom any further information may be obtained. There is no specified date for the delivery of MSS.

AN ENGINEER'S LIFE AT SEA.—XVI.

BY A SEA-GOING ENGINEER.

(Continued from page 473.)

FIREMEN, SICKNESS, AND BAD FOOD.

AMONG firemen there are, as might be expected, many varieties. There is usually a fresh supply every voyage, and their combinations are as varied as those of the kaleidoscope. Though selected of one apparently uniform quality, no sooner is the vessel fairly on her voyage than one will develop an unruly disposition, not only making all the others uncomfortable, but sometimes changing the character of the whole group and making them difficult to manage. Then another falls ill, and it turns out that he was ill when he came, and, being unfit for work on shore, thought that he would make sure of his food and lodgings and medical attendance for a few weeks, or months, with some pay at the end, taking his chance of whatever disagreeables might arise, in the knowledge that these could not be worse than if he were starving ashore. As firemen are not always of the most robust appearance, it would puzzle the best medical man to judge, when engaging them, who were or were not unfit for work by illness or laziness. Besides this, the most vigorous are frequently the most unmanageable. Though size and strength in an engineer may keep such men in order, yet ruling by physical strength is a poor way. Such an engineer, though obeyed with more apparent alacrity than another, is really worse served than those who regard the men as human, and not mere machines. There is a well authenticated case of a "second" who, finding complaints made by one of the men that he could not stand the heat of the fires, had the man lashed to the iron companion ladder in front of the opened fire-doors. The victim died in consequence, but a doctor being on board, the case was, it is said, entered in the log-book as one of apoplexy, or some other natural cause, and the matter was hushed up. According to latest accounts that "second" was still in the same employ. Strict discipline can be maintained by far better means than this.

It is often difficult to know what to do with a man who "lays up." In a case of real illness he will meet with sympathy, tempered, perhaps, with an occasional growl from those who are doing his work; but when a man has purposely come aboard ill, his comforts must be of the scantiest and his medicine of the nastiest, or he will lie in his bunk all the voyage. One fireman, suspected of being a loafer, was summoned aft to receive his medicine, which was concocted entirely with a view to its being of specially atrocious flavour. He drank it calmly to the bottom, looked into the glass, and, seeing a few dregs left, drained these to the bottom; then, expressing his gratitude for the good he knew it was going to do to him, walked feebly away, leaving the stewards in consternation at his hardihood. Engineers have to use their judgment in such cases, and sometimes must have a man driven to his work by physical force or the threat of it, though in one unfortunate instance a man so driven died most inconveniently on the deck. Sometimes one of the men, envying the happy lot of the loafer in his bunk, will fall ill also, so that loafer No. 1 has to be driven forth to do the work of No. 2. Where such happens, it will almost certainly come to pass that the illness will go round all the men in rotation one at a time, as if pre-arranged; thus the one who set the ball rolling is forced to do his share of work till his turn comes round for well-earned repose. Soon after the writer went to sea, he mentioned to his chief that he was out of sorts. To his surprise, he heard that the chief also was ill; and on narrating the coincidence to the "second," he discovered to his disgust that he also was similarly afflicted. The fact is, that at sea a man *must* work, whether well or ill, unless absolutely unfitted for it.

Firemen are usually well in port, for there the drawbacks of a forecastle residence are more felt, and there is also the ever-present fear of being left behind in a foreign hospital. It can thus easily be seen that a fireman's lot is no bed of roses, and that his pay is well earned. Though his pay exceeds that of a sailor, while his hardships may not be greater than those of his acquaintances who live and work on shore, when work is to be had, and though beneath both him and them are others yet worse off, yet the engineer should remember that the fireman is but weighted down a little lower than himself by the same competition which is diminishing his own pay as well as the profits of the shipowner, sucking down wages and profits that rents may rise. Many of these firemen, in spite of all disadvantages, give promise of the highest qualities, only awaiting development.

In selecting firemen, those are especially to be avoided who parade their experience when applying for work. These are the sea-lawyers, dreaded of captains; or rather they are captain, and engineer, and steward all in one. It is amusing to see one such, sitting in the centre of a crowd of firemen and sailors, discoursing, with voluble tongue, of how this engineer or that captain acted in certain circumstances, and always to the disparagement of those he is under at the time. He narrates minutely how well they were provisioned in the last ship; for such a one always has found "the last ship" so full of perfections that one wonders why he ever left it.

Sailors, and firemen, too, often have good cause to complain of their food, and grumble sometimes to the verge of mutiny by refusing to work with the strength which they have *not* derived from insufficient and bad food. They know that in many cases, unless they insist on getting "their whack," they will go short. Though there are many worthy and kind-hearted men among ship captains, yet, the opposite being the rule, grumbling has also become the rule, and the men cannot always deny themselves the pleasure of complaining, even when well treated—like the man who was never happy unless he was miserable.

In one ship, where, as the story goes, the captain was determined to conquer by kindness, he had a goose cooked, and sent to the men at Christmas. Curiosity caused them to gather about the galley door to discuss the event, the conclusion being that there "must be something wrong with the —— goose or it would not have been sent" to them. Such discontent throws light on all past and present relations in that and every other ship. On another similar occasion a captain was said to have sent a plumpudding to his men. After consuming it, a deputation went aft to return thanks, and with the request that the next time a plumpudding was sent to them there might be more plums in it. With complaints of bad food the engineers cannot directly deal. The men have to fight their own battle, and, as a rule, they are well able to do so. Of course, if they refuse work in consequence of insufficient food, the question comes prominently to the front; but a captain will do much to avoid this. When a captain is acting fairly to his men, the most effective cure he can apply is to put them strictly on their legal allowance, stopping all extras. The threat of this will usually stop any unreasonable complaints.

With engineers or firemen in opposition to the powers that be, care must be taken to keep out of the log book, except their case is good. Once a formal complaint is laid before the captain, he has to "log" the offender, and this he dare not afterwards erase. The log book, after each voyage, is scrutinised by the Board of Trade, and so strict are they that in one case, when a large blot had fallen on the page, the captain had to make a formal declaration that nothing was concealed by it. Only when other means fail should a man be logged. It not only makes him reckless for the rest of the voyage, on the principle of being "as well hanged for a sheep as for a lamb," but the official investigation of the matter at home leads to much trouble and delay, and its issue is uncertain. Once the voyage is over, many matters which seemed at the time to be of importance sink into insignificance. Unless in very bad cases, there are many ways of punishing a man at sea without any formal trial ashore. In some cases an effective way is to turn the laugh of his fellows against an offender, such as telling him that, as his knowledge is of a superior kind, you would be glad if he would take charge of the work himself. Such a request rarely fails to have a disconcerting effect, whether stated jocularly or with contempt.

The Board of Trade is the seafarer's best friend, whether he hail from the sooty or the tarry side of the ship. Argus-eyed, hundred-handed, its agents, the consuls, are in every port to redress wrongs and give assistance and advice of every kind to whoever applies for it, and none dare prevent such application. Though a captain or engineer may complain that it shows an undue partiality for firemen and sailors in order to display its supremacy, yet its influence is for good, and extends far beyond its visible limits, the dread of it preventing even an attempt at such oppression as was once openly practised—for justice was tardy and uncertain in the days preceding the steamship and telegraph.

TORPEDO BOATS FOR INDIA.

Some interesting speed trials of a new first-class torpedo boat built of steel—one of three being built for the Government of India by Messrs. John Thornycroft and Co., Chiswick—were made on the Thames, in the Lower Hope, opposite Canvey Island, between Southend and Thames Haven, on Friday last. The vessel, to which the name of "boat" seems almost inapplicable, she being 133½ft. in length, started from Chiswick in the mist of early morning, shipped her inspectors and visitors at Westminster, and then bore on for the open river below Gravesend.

The vessel was in charge of Mr. Tweddle and Mr. Barnaby, and Mr. Brown had charge of the machinery. Mr. Smale and Mr. Melrose, the Admiralty inspectors, attended on behalf of the Indian Government, and there were also present Captain Eardley Wilmot, R.N., of the Intelligence Department of the Royal Navy, and Captain Rosseau, of the Austrian Imperial Navy, the Naval Attaché of the Austrian Embassy. The vessel manœuvred splendidly through the crowded pool, and was under steam steering gear, which allowed her to keep her speed pretty evenly and to run past obstructions safely. She has, for this class of vessel, an exceptionally large beam of 14ft. 9in., in order to carry a heavy deck armament, so that she may be of a dual use as either a gunboat or a torpedo boat, and to give full advantage to a great rudder power with which she is supplied. She is fitted, as the three Chiswick vessels will be, with the Thornycroft side rudders, which, besides enabling the boats to steer with remarkable facility, either astern or ahead, possess, in conjunction with a bottom guard, the very important advantage of completely protecting the propeller from the danger of fouling by ropes, nets, or other floating obstructions. The armament of the vessel is to be the same as that of recent boats built for the Royal Navy of this class—namely, four revolving deck tubes and one fixed bow tube, all discharging 14 Whitehead torpedoes by means of a gunpowder impulse.

There is a raised deck nearly the whole length of the vessel, and two conning towers, one fore and one aft. On these will be mounted the larger calibre Nordenfelt guns and other effective weapons for her use as a gunboat. In the conning towers are the means of steering by steam or hand, and she can be steered from fore and aft, at both places by either steam or hand, so that if the steam steering should break down, the hand steering can be resorted to.

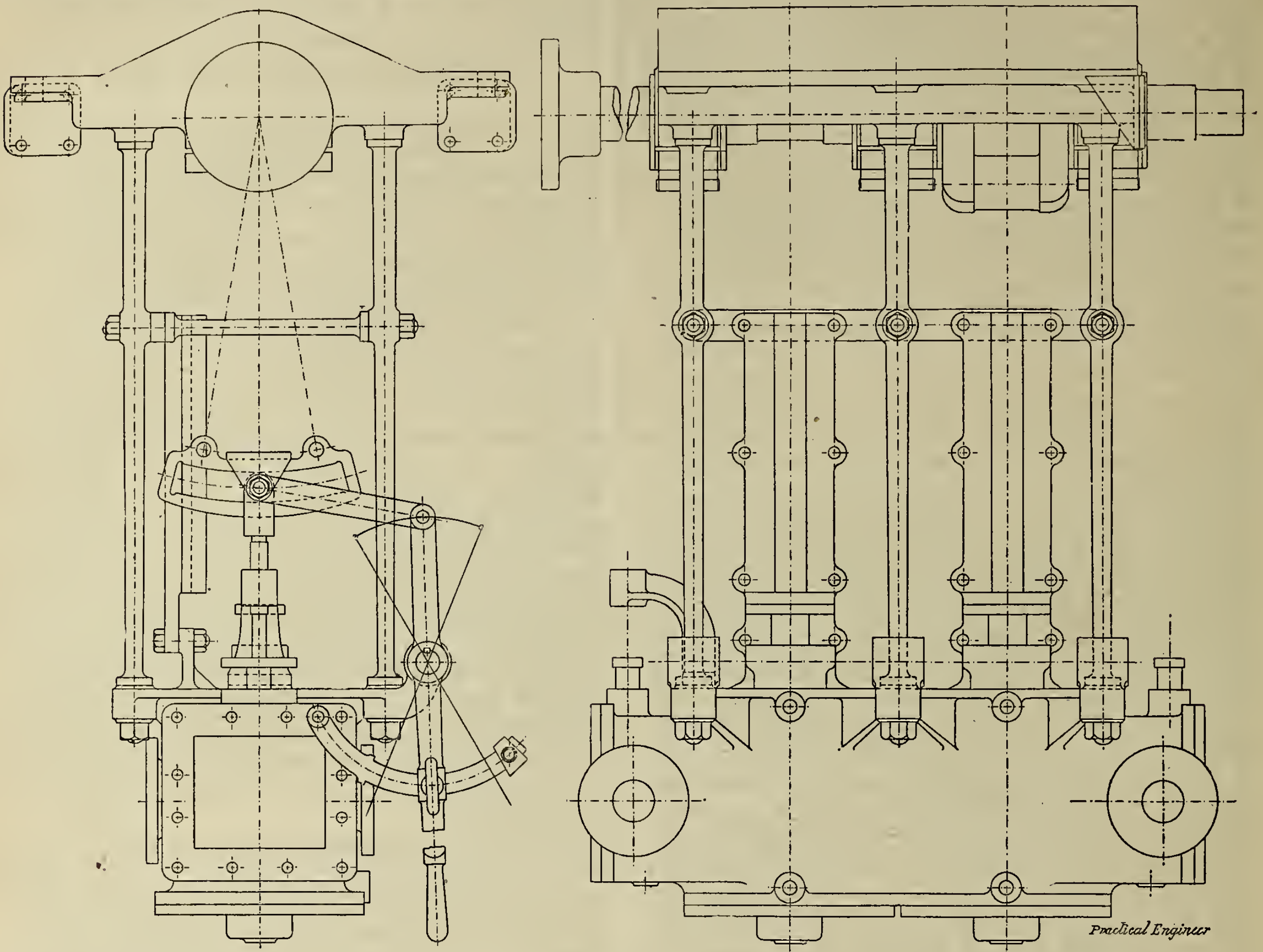
The complement of the vessel is three officers and thirteen men, and the load carried on Friday last was 20 tons, including 10 tons of coal; but she can carry 20 tons of coal, which would enable her to run, it was estimated on her guaranteed speed (22 knots), 3,000 knots.

Her propelling machinery consists of 1,300 indicated horse-power triple-expansion engines, the steam being supplied by two of the firm's patent water-tube boilers. These boilers take up the same amount of room as a single locomotive of the same power, and the two increase the boat's chances of existence, as with one boiler disabled she could still steam at 18 knots, on the estimate that her guaranteed power of 22 knots was reached. The boilers have an exceptionally large heating surface, three square feet per indicated horse power, and are regarded as requiring a very moderate wind pressure, the manometer in the stokehold registering only from 1in. to 1½in. of water. There has not been, it is significant to observe, any difficulty experienced with these boilers, either in the way of leaky tubes or priming, and the danger of accident through faulty management is greatly reduced. The weight of the vessel and load yesterday was about 96 tons.

Gravesend was reached a little after noon, the passage down having been difficult owing to the crowd of vessels running up with the tide, and at twenty minutes past she commenced her fast steaming. The mean of all the running during the trials was 23·156 knots, as against the guaranteed speed of 22 knots. She was then tried full speed astern, and steered by hand and by steam. She went in circles from head to port in 1min. 26sec., from head to starboard in 1min. 23sec., from stern to port in 1min. 43sec., and from stem to starboard in 1min. 29sec.

The vessel returned to Chiswick at night, and the inspectors expressed themselves quite satisfied after the exhaustive experiments with the vessel. She will go out to Bombay by steam.

LAUNCH ENGINES VII.—General Arrangement.



It has been thought desirable to supplement the detail working drawings of launch engines which have appeared in *The Practical Engineer* from time to time with a general arrangement of the engines, to assist our young readers in better understanding the design of the same.

It will be seen that the type will be of the inverted cylinder class, the cylinders being supported on six columns, which enables all the working parts to be easily got at for examination, packing of stuffing boxes, &c., when necessary, a point that should be studied when designing a set of engines, more especially when intended for marine purposes. As will be seen, the slide valves are on the outside of the cylinders, thus making the motions more readily accessible than when placed between the cylinders.

The feed and bilge pumps are worked direct from the pump eccentric and attached to the bed of the engine, on facings provided for that purpose. It is thought unnecessary to give figured dimensions in these drawings, as the various details were fully dimensioned, and the present drawings are intended to give a general outline of the engines when erected.

The Brussels Exhibition.—The presidents, vice presidents, and jurors appointed to represent the British Empire at the Brussels International Exhibition yesterday week presented the Lord Mayor, as President as the British Committee, with an address, acknowledging the valuable services rendered by Mr. S. Lee Bapty in his capacity as Commissioner-General. It was stated that nearly all the other sections in the exhibition had been subsidised by their respective governments, but notwithstanding this the British Section bore favourable contrast with any other court in the exhibition, not only as regarded the construction and decoration of the building, but also in the general organisation. On the date appointed for the opening of the Exhibition the British court was the only one completed.

ROLLING SEAMLESS TUBES.*

Steel possesses high qualities and great strength, which make it peculiarly fitted for many purposes both in industry and the arts. The same observations apply in a lesser degree to toughened or hard glass, and yet these materials have been comparatively neglected. This neglect is owing in a great measure to the fact that steel in its present cheapest form and toughened glass are somewhat new articles, and that until recent discoveries were made difficulties were encountered in working and transforming them that induced the general public to use, by preference, wrought iron and soft glass, which could be welded and cut respectively, as steel and hard glass could not be, by the means generally known.

The use of steel in replacing wrought iron has been very slow. In recent times only has a general advance in this respect been made. This advance is partly owing to the new methods of producing steel, the Bessemer, the Siemens, the basic process of Gilchrist and Thomas, and partly also by newly-discovered means of manipulating the products of these inventions.

The subject of this paper will be a new and important invention recently made in the manipulation of steel. The process consists generally in a method of rolling metal into seamless tubes, and it will contribute greatly to increase the use of steel, and principally of those kinds of cheap steel produced by the methods mentioned above. The open-hearth or Siemens steel, above all, possesses the advantage of being cheap, of having the right amount of toughness, homogeneousness, and other qualities which fit it for the special purpose of rolling solid ingots direct into tubes.

Most engineers will have heard of the tube-rolling process of Messrs. Mannesmann. The modest title barely indicates its great importance. I myself took an interest in this new invention, because I was desirous of increasing the use of open-hearth steel, which, as well as copper, I was informed was specially adapted to the process, for which wrought iron was comparatively unsuitable.

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* Paper by F. Siemens, C.E., read before Section G of the British Association.

Tubes occupy an important place in the wants of mankind. Besides their use as tubes, properly so called, they possess also the most advantageous form for columns, rods, axles, bearers, struts, &c. A given quantity of material can be formed into no shape so strong as the tubular.

Hitherto steel tubes could only be made with difficulty and at high cost, by a complicated process, with imperfectly welded seams and a longitudinal fibre. Now, from a rough ingot of cheap steel, with one, or at most two operations, a perfect tube without seam and with a circular fibre is produced. It may be seen from this bare statement how great is the importance of this invention. If it is considered that by the process in question tubes of great length and diameter, and of almost any desired thickness of metal, can be produced at a comparatively low cost, air-tight, and possessing treble or quadruple the resisting power of the best welded tubes of wrought iron, it can hardly be doubted that a great future is opened out for their use in technical arts, industries, architecture, and also in war materials. New branches of industry may also be expected to arise, as we now have the means of bringing into use the best of material in the lightest and at the same time strongest form.

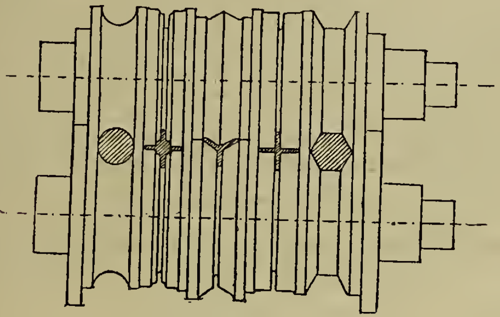
Fig. 1.

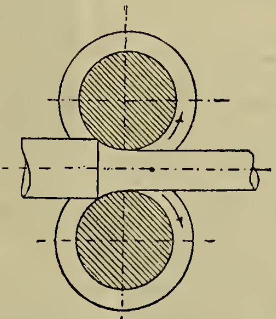
Fig 2.

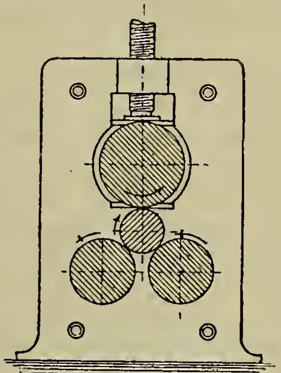
Fig. 3.

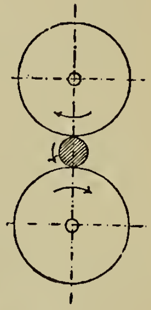
Fig 4.

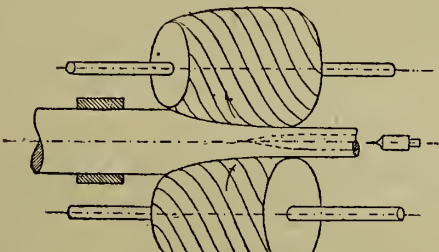
Fig. 5.

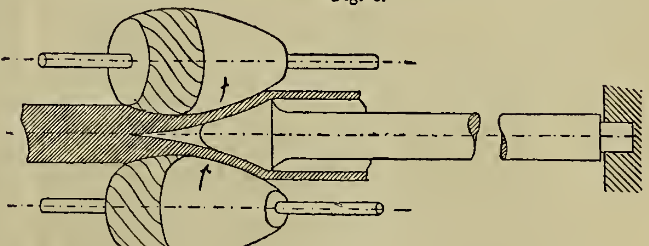
Fig. 6.

At the present time, to roll a bar of iron, two horizontal rolls, as shown in figs. 1 and 2, revolving in opposite directions, are used. If the section of the finished bar is required to be of any given form, grooves are cut around the rolls of the sectional form which the bar is required to assume. Passed longitudinally between the revolving rolls, the bar is forced into the grooves, and reappears moulded to the desired form. The rolls do not make the bar revolve ; they act simply on its surface, drawing the material forward, and, forcing it into the prepared grooves, at the same time elongate it and reduce its sectional area. The fibre produced in the finished product is, of course, longitudinal. Tubes are also made in this way : The prepared sheet of wrought iron is bent till the sides overlap, and the longitudinal seam thus made is welded while passing through the rolls, on a mandrel placed inside. The ordinary patent welded wrought-iron tubes made in this way have also a longitudinal fibre.

Another way (figs. 3 and 4) of rolling is known and is used for straightening and polishing bars, to which a rotating motion is imparted by two or three rolls revolving in the same direction. These rolls are for the most part placed parallel to one another, and the bar to be operated on is introduced in the direction of their longitudinal axis, that is at the ends, instead of at a right angle to the rolls. In such rolls the bar is not drawn forward, but simply rotates, and if sufficient pressure is given the bar is elongated, but no decided fibre is produced.

Between the two kinds of rolling described above, which may for convenience be called longitudinal and circular respectively, another system of polishing and straightening bars and tubes occupies a kind of middle position.

So also does the Mannesmann tube-rolling process. The systems differ, however ; the first acts on the surface only of the bar or finished tube, whereas the latter actually makes the tube, and in making it displaces the material of the bar or ingot acted on, and imparts to it a fibre running in a spiral around it. In both systems two or three rolls may be used together, turning in the same direction, and consequently imparting a rotating movement in the opposite direction to a bar laid between them. The two or more rolls (figs. 5 and 5), however, do not lie normally, nor even parallel, but at angles to the axis of each other, and the axis of these rolls cross one another and that of the bar, forming somewhere in space acute angles in opposite directions with each other, and with the bar lying between them. When thus set the rolls act on the bar to draw it forward as well as to make it revolve, or, in other words, they impart to it a spiral movement. Though constructively both systems of mills may appear much the same, they differ widely in their mode of working and in their results. This arises from the position which the article acted upon, and which we will continue to call a bar, is made to take up, and the very different action and form of the rolls. In the Mannesmann machine a certain relation is maintained between the forward movement of the bar and its rotating movement, and if the proportion between longitudinal and rotary motion is properly adjusted to the special material acted on, the displacement in the substance of the bar is regulated so that a systematic twist is given to the fibre, by which not only irregular breakage of the material is avoided, but an energetic working action is secured, causing the great strength and toughness the tubes produced by this process are proved to possess.

The old straightening and polishing machine, although outwardly similar to the Mannesmann tube-rolling machine, owing to the form and position of the rolls and bar, admits of no twisting and displacement of material, and consequently this machine confines itself to surface action, as, indeed, it professes to do by its title.

The following remarks may assist in clearing up this singular difference, and explain the peculiar action of the Mannesmann rolls, which, while acting on the outer surface of a solid bar, produce a regular hollow space inside the same—in short, a tube. To obtain a simple forward spiral action of the bar, the length of the rolls is immaterial ; it will take place when the rolls are reduced to the form of thin discs. Supposing the disc to be infinitely thin, or what is the same thing, that their outer edges are reduced to a mathematical line and no sliding motion takes place, the bar must still move forward spirally, its spiral velocity being equal to the velocity of the outer circumference of the discs. If, instead of one pair of such thin discs, several pairs of discs of regularly increasing diameters are made to revolve on the same axis, the outer circumference of each disc will revolve with greater velocity than that of the preceding one. The same bar is, however, drawn forward through the several pairs of discs, and thus as each part of the bar enters successively a more advanced pair of discs, the velocity with which that portion of the bar rotates increases, and it is drawn forward by each succeeding pair of discs as they catch hold of it with ever-increasing speed.

It will be understood that a bar passing through such a series of discs, no slipping being possible, the material of which it is composed cannot retain its original area or volume. The diameter of the bar being regulated by the discs, whilst simultaneously a violent stretching action is carried on, the material required can only be drawn from the inside of the bar, and thus a hollow space is formed.

Instead of this peculiar arrangement of discs, a conical, or rather conoidal, pair of rolls, which amount to the same thing as the discs, considered as joined together, may be provided. It follows that a bar or rod of suitable dimensions which is passed through the Mannesmann rolls will, provided its substance is sufficiently homogeneous and plastic, undergo a violent twisting and stretching action, the fibre being spun as is the fibre in a rope, on account of which the process may appropriately be called a tortional process. The bar in its passage through the rolls is twisted as thread is twisted in a spinning machine. As, however, it cannot be fed from the outside as is the thread, and, as has been said, the diameter cannot be reduced on account of the action of the rolls, it is forced to draw on the interior for a supply of material.

I will attempt to explain in another way.

The tube is made thus: A bar is placed between the conoidal rolls at the part where their diameter being least the speed at which they move to make a revolution is also least. The rolls seize the bar and draw it into contact with parts of the cones, which move more and more rapidly, though, owing to the way in which the rolls are set, the space left between them for the passage of the bar decreases slightly. Slight, however, as is this decrease, a certain amount of material has to be shifted. The action of the rolls prevents this material from being taken from outside the bar, and it is drawn from the interior; hence the hollow, hence the tube. Soon after entering the rolls a small central fracture is formed, which widens to a hollow space as the increased stretch is made to take effect in an increased twist acted on from the surface.

The increasing twist of the fibre of the bar while passing through the rolls, and that peculiar relation kept up between longitudinal and turning action, is the characteristic of the Mannesmann tube-rolling machine, and this action it is that enables it to make a tube from a solid bar or ingot.

Though the bar is thus converted into a tube by the action of the rolls, and their action only, a mandrel is generally used to finish and smooth the interior and enlarge the tube. This use of the mandrel has led to the erroneous belief that it is necessary to form a hole in the bar. No machine, however, could stand the strain if it were attempted to force a mandrel longitudinally through a solid bar of hot steel. Such an operation is impossible.

Just sufficient power is used to form the hollow in the bar from the action of the rolls on its outside, and into this hollow the mandrel enters, smooths the inside, and, when required, enlarges the tube. Thus we have the strange experience in rolling, that by one action the bar is made hollow, and also longer and wider than when it entered the rolls a few seconds before.

In a specimen placed before you is the proof that the hollow in the interior of the bar is formed without the intervention of a mandrel. This piece in its present shape is obtained by interrupting the action of the rolls whilst the bar is still on its way through them, and then breaking off the bar so as to expose that part where the hollow is just commencing to form. This piece is sound in its solid part, as well as in the hollow part, and the inner surface of the commencing tube is crystalline. This shows that no mandrel can have acted on it. Besides this, the inner surface is not oxydised as it would have been if it had been exposed to the air at a red or white heat. The bright surface is preserved because no air need enter the tube during formation. Until such a specimen as you have before you is cut open a vacuum exists in the interior, both ends being hermetically closed. Such a specimen is made by slightly pointing the bar at the two ends so that they escape the full action of the rolls at its entry and exit. This curious result can always be obtained, and it quite disposes of the allegation that the hole is made by a mandrel. The specimen shows also both how the tube in the centre commences by a fracture of the metal and widens out, and also the twist of the fibre is seen, which has the appearance of a rope. This peculiar twist of the fibre assists in giving the tubes their great toughness and resisting power. The various specimens before you are mostly produced from the relatively cheap open-hearth steel. The Mannesmann process in shaping metals upsets most of the hitherto accepted ideas and conditions, inasmuch as, instead of avoiding any twist of the fibre, it by one operation gives the greatest possible twist to the fibre, with a corresponding stretch of the material. It moreover, as I have already said, may, assisted by a mandrel, increase the outer diameter of a bar instead of diminishing it, as do all other rolling mills. The tube produced by the Mannesmann process is generally greater in diameter than the bar from which it is formed. The child is, at its birth, larger than its parent.

From this description, and the facts here attempted to be given, it is evident that we have in the Mannesmann process a system of rolling as new as it is capable of producing effects hitherto not contemplated. In combining all the various systems of rolling, as described above, it may claim to be called the universal system of rolling, in which all hithero known rolling processes represent a part. The old polishing and straightening machine could never, it is evident, produce like results, because the essential constructive conditions are wanting. It is remarkable that not only competitors, but otherwise competent men, rejected the Mannesmann process as either not new or as being wrong in principle and generally impracticable, and this sweeping condemnation was supported by arguments apparently logical and sound. I trust this short explanation of an intricate and novel process, and I may say principle, of rolling tubes from solid ingots may assist in dispelling the incredulity and prejudice that has grown up around it. In face of the numerous possible applications of the process, great difficulties have to be mastered, but it may be safely foretold that these will mostly be overcome on account of the true principle on which the process is based, and by the energy and intelligence that have conducted it to its present advanced state.

COMBINING INDICATOR DIAGRAMS OF COMPOUND ENGINE.—II.

(*Concluded from page* 460.)

It will be seen from what was said in our last article that the usual mode of combining indicator diagrams is incorrect, and cannot be considered as a reliable method for instituting a comparison between the actual and theoretical volumes and pressures of the steam. This was, we believe, first pointed out by Mr. Schonheyder, in a letter to a contemporary in October 1871, and to him is due the method of combining diagrams described below.

The first set to which we wish to refer are those shown in fig. 3, and are taken from a horizontal tandem compound engine with cylinders 17in. and 30in. diameter, 5ft. stroke, running at 70 revolutions per minute. The cylinders are clothed, but not jacketed. Automatic cut-off Corliss valves are attached to the high-pressure cylinder, while the low-pressure is fitted with an ordinary slide valve. The boiler pressure is 86lb. The average pressure in the high-pressure cylinder is 42lb., giving 202·4 I.H.P. The average pressure in the low-pressure cylinder is 12·67lb., giving 189·9 I.H.P.

Before the diagrams can be compared in the way proposed, they must be reduced to a uniform standard of pressure, and the lengths of the diagrams must then be reduced in proportion to the cylinder ratios. The high-pressure diagram is then placed at a distance CY = its clearance space from OY, and an hyperbola BA with axes OY, OX is then drawn touching the diagram. The line AR is then drawn parallel to OX, so that OR is equal to the initial pressure in the large cylinder. This cuts the high-pressure compression curve in D. Then it is evident that the volume AD at the pressure OR represents the amount of steam which the small cylinder discharges at each stroke into the large one.

Now, in the low-pressure diagram mark off ES to represent the clearance in the L.P. cylinder, and continue the compression line WZ by an hyperbola to meet AR in D. Then the volume of steam shut in the large cylinder by compression is represented by DS at the pressure OR. Now set the low-pressure diagram so that D lies on the intersection of the high-pressure compression curve with AR. (In the actual figure this is already done, but in the description we have so far considered them as if they were on separate pieces of tracing paper.) Then in the low-pressure cylinder we have a volume of steam DS, to which is added from the small cylinder a volume AD, and hence the total amount of steam in the large cylinder which expands is SA, and the expansion curve of this is the hyperbola AV drawn through A with reference to the axes SL, LX, and this represents the expansion curve which the steam might be expected to follow if the expansion followed the law $p\ v =$ a constant.

The theoretical area on the same basis is that contained between the expansion curves BA, AV, the lines VM, MW, and the compression curves WZD, DC, and the line CB.

Of course, in comparing the loss, allowance must be made for the parts of the diagrams which overlap.

It will be seen that the diagrams compared are exceptionally good. The expansion curve of the small cylinder follows the hyperbola closely; the high-pressure exhaust and the low-pressure admission line overlap in a way that suggests little loss between the cylinders, while the volume of steam shown by the actual low-pressure diagram is very nearly that which might be expected from the theoretical considerations. Usually, the low-pressure diagram would fall considerably below the hyperbola AV, the low-pressure diagrams in practice generally showing materially less steam than those from the high-pressure cylinder.

It is possible that the load increased before the low-pressure diagram was taken, and hence that diagram may not represent the action of the same volume of steam as that shown by the diagram from the small cylinder.

This is a point which should always receive careful attention when accurate results are needed, and in such cases it is advisable to indicate both cylinders simultaneously. This is, however, generally impracticable, and an approximation may be obtained by taking several sets of diagrams from the cylinders alternately, and from these drawing a mean diagram.

The best arrangement for the accurate indication of a compound engine which we have seen is that on the three-cylinder engine in the Whitworth laboratory, at Owens College, where arrangements are made for indicating each end of each cylinder simultaneously.

Fig. 4 shows diagrams taken from one of the compound non-condensing portable engines which have recently come into prominence—the cylinders being 8in. and 14in. diameter; stroke, 1ft. 4in.; revolutions 125 per minute; cranks set at right angles; automatic cut-off slide valve to high-pressure cylinder; ordinary slide valve to low-pressure; boiler pressure 120lb. per square inch.

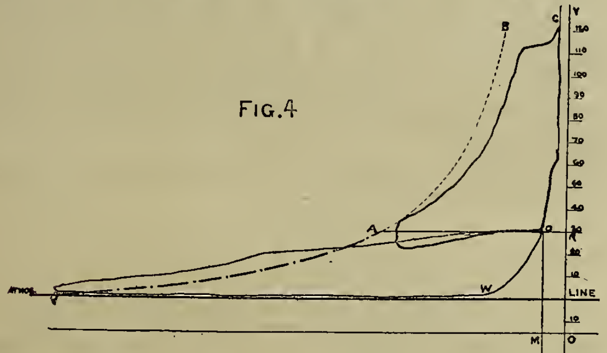
FIG.4

Pursuing the same method of construction as that described in the case of fig. 3, the line AR falls a little below the lower end of the high-pressure compression curve. This must, therefore, be produced to meet the line AR in D. In these diagrams it happens by a peculiar coincidence that the compression in the large cylinder just filled the clearance at the absolute pressure OR, and that the volume of the steam shut up in the high-pressure cylinder and clearance is just equal to DR. It therefore follows that the line LS of fig. 3 in this case coincides with OY, and therefore the expansion curve AV of the low-pressure cylinder is the continuation of the hyperbola BA. It will thus be seen that in this particular instance the same result is obtained as if the incorrect method first described had been followed of placing the diagrams at the distance of their clearances from OY, and simply drawing an hyperbola to touch the high-pressure diagram.

It will be seen that in this case the actual low-pressure expansion lies beyond AV, showing a very considerable gain of steam. This feature repeats itself whenever this particular engine is indicated, and is due to live steam having access to the low-pressure cylinder through a valve which is used to admit live steam when starting the engine, and which apparently does not afterwards shut it off.

This peculiar feature has, in some cases, been the result of the dishonest use of warming valves and similar arrangements by engine attendants anxious to show a large indicated horse power with a low rate of coal consumption. Of course, to do this most effectively, the live steam is only admitted while the large cylinder is being indicated.

The method of combining diagrams which has been described is, it will be understood, applicable to three or more cylinders just as readily as to two, and no difficulty will be met with in making use of it if the principles we have laid down are followed.

The main advantages of combining diagrams are that the actual proportional work of each cylinder is shown in its proper relation, the defects of each cylinder appear in their proper ratios, and the alteration of the volume and pressure of the steam is graphically compared with those of steam following throughout the law $pv =$ a constant.

INFLUENCE OF FLANGED SEAMS ON THE STRENGTH OF FURNACE TUBES.—II.

(Continued from page 489.)

The ring marked B was fitted with the external stiffening ring shown in fig. 2, Plate I.

The thickness of each ring was measured at four test holes equally distributed throughout the circumference, and the results are given in Table No. 2, and also on fig. 3, Plate I.

Table No. 2.

Number of Test Hole.	Distinguishing Letter on Ring.			
	A.	B.	C.	D.
	Inch.	Inch.	Inch.	Inch.
1	·523 weld	·567 weld	·543 weld	·536 weld
2	·543	·526	·548	·541
3	·545	·534	·547	·543
4	·538	·529	·546	·534
Mean of unwelded part of plate.	·542	·529	·547	·539

In forming the rings, the plate in each case was passed through ordinary bending rolls until it assumed the cylindrical form. Its ends, which were square, or nearly so, were then secured together at a distance from each other of about $\frac{5}{8}$ of an inch, and into this space short glut pieces of mild scrap steel plate, of the same quality as the ring, were welded by hand. The ring and glut pieces were heated for this purpose in an open coal fire, and about 5in. or 6in. of welding was completed at each heat. The flanging was, I understood, also done by hand. The rings were stated to have been annealed after being flanged, by heating them over the fire which had been used for welding the seams. The caulking rinks between the flanges were about $\frac{3}{16}$in. thick by $2\frac{3}{8}$in. broad.

The plates were made by Messrs. The Steel Company of Scotland. A specimen from each ring was cut into twelve strips, six of which were tested by bending and the others by pulling stress. One half of the bending tests were made with the material in its normal condition, *i.e.*, as cut from the ring, and the others with material which had been previously annealed.

All the pieces bent through an angle of 180 deg. without flaw or fracture.

The pulling pieces were similar, as regards their condition to the bending pieces, and from the *mean* results of the tests, which are given in Table No. 3, it will be seen that they were of mild quality:—

Table No. 3.

Condition of the Test Pieces.		Distinguishing Letter on the Ring from which the Test Pieces were taken.			
		A.	B.	C.	D.
Normal ..	Tensile strength per square inch.	26·9 tons	25·0 tons	26·9 tons	26·9 tons
	Elongation in 10″	22·3 p. cent.	21·1 p. cent.	22·1 p. cent.	19·3 p. cent.
Annealed.	Tensile strength per square inch.	25·5 tons	24·3 tons	25·6 tons	25·7 tons
	Elongation in 10″	26·3 p. cent.	26·6 p. cent.	27·8 p. cent.	25·8 p. cent.

The pressure was produced by a double-throw steam pump, and was registered by two of the board's gauges that were made specially, and are kept exclusively for experimental purposes. These gauges were accurately adjusted in my presence just before leaving London, and I have no reason for supposing that their indications during the experiments were other than accurate.

The several rings of the experimental tube were collapsed consecutively, thus making four distinct experiments, the details of which are given in Table No. 4 and context:—

TABLE No. 4, RESULTS OF FIRST EXPERIMENT.

Pressure applied per Square Inch.	Distinguishing Letter on Ring.								Length of Tube.
	A.		B.		C.		D.		
	Diameter (internally) at Mid-Length.		Diameter (internally) at Mid-Length.		Diameter (internally) at Mid-Length.		Diameter (internally) at Mid-Length.		
	Vertically.	Horizontally.	Vertically.	Horizontally.	Vertically.	Horizontally.	Vertically.	Horizontally.	
Lb.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Ft. In.
0	$41\frac{60}{64}$	$42\frac{4}{64}$ bare	$41\frac{60}{64}$ full	$41\frac{58}{64}$	$41\frac{60}{64}$ full	$41\frac{60}{64}$ full	$42\frac{4}{64}$	$41\frac{54}{64}$	7 $8\frac{15}{16}$
100	$41\frac{60}{64}$	$42\frac{4}{64}$ bare	$41\frac{60}{64}$ full	$41\frac{58}{64}$	$41\frac{60}{64}$ full	$41\frac{60}{64}$ full	$42\frac{4}{64}$	$41\frac{54}{64}$	7 $8\frac{15}{16}$
200	$41\frac{60}{64}$	$42\frac{4}{64}$ bare	$41\frac{60}{64}$ full	$41\frac{58}{64}$	$41\frac{60}{64}$ full	$41\frac{60}{64}$ full	$42\frac{4}{64}$	$41\frac{54}{64}$	7 $8\frac{15}{16}$
300	$41\frac{60}{64}$	$42\frac{4}{64}$ bare	$41\frac{60}{64}$ full	$41\frac{56}{64}$	$41\frac{59}{64}$ full	$41\frac{59}{64}$ full	$42\frac{3}{64}$	$41\frac{53}{64}$	7 $8\frac{15}{16}$
400	$41\frac{59}{64}$	$42\frac{3}{64}$ bare	$41\frac{58}{64}$ full	$41\frac{56}{64}$	$41\frac{58}{64}$ full	$41\frac{58}{64}$ full	$42\frac{3}{64}$	$41\frac{52}{64}$ bare	7 $8\frac{15}{16}$
500	$41\frac{58}{64}$	$42\frac{2}{64}$ bare	$41\frac{58}{64}$	$41\frac{56}{64}$	$41\frac{58}{64}$	$41\frac{58}{64}$	$42\frac{2}{64}$ bare	$41\frac{52}{64}$ bare	7 $8\frac{15}{16}$
600	$41\frac{57}{64}$	$42\frac{1}{64}$	$41\frac{57}{64}$	$41\frac{54}{64}$	$41\frac{57}{64}$	$41\frac{57}{64}$ full	$42\frac{1}{64}$	$41\frac{50}{64}$ full	7 $8\frac{31}{32}$
700	$41\frac{57}{64}$	$42\frac{1}{64}$	$41\frac{52}{64}$ full	$41\frac{47}{64}$	$41\frac{56}{64}$	$41\frac{57}{64}$ full	42 bare	$41\frac{49}{64}$	7 $9\frac{1}{16}$
760	$41\frac{56}{64}$		Collapsed	suddenly.					

The tube when first tested sustained a pressure of 760lb. per square inch for a few minutes, and then collapsed at the middle of ring B. The bulge extended from flange to flange, and was located at about 6in. from the weld, its greatest width and depth being about 14in. and 2in. respectively; but these dimensions would have been greatly increased if the pressure had not been quickly released.

The permanent set in the tube, after it had been subjected to a pressure of 600lb. per square inch, was only about $\frac{1}{64}$in. in the horizontal direction of ring B, and was not measurable, with the appliances at hand, at any of the other points which had been gauged for deformation. The permanent sets found at the completion of the test are given in Table No. 5 :—

TABLE No. 5.

Distinguishing Letter on Ring.								Increase in Length of Tube.
A.		B.		C.		D.		
Vertically.	Horizontally	Vertically.	Horizontally	Vertically.	Horizontally	Vertically.	Horizontally	
Inch.	Inch.	Inch.	Inch.	Inch.	Inch.	Inch.	Inch.	Inch.
Nil.	Nil.	$\frac{1}{4}$	2	Nil.	Nil.	$\frac{3}{64}$	$\frac{2}{64}$	$\frac{1}{32}$

After the above measurements were taken, a cast-iron hoop, about $7\frac{1}{8}$in. broad by $3\frac{1}{4}$in. thick, was placed inside of ring B, as shown by figs. 3 and 4, Plate II., and wedges were driven into the space between it and the ring, to prevent an extension of the bulge, and to ensure the collapse of one or more of the other rings at the subsequent test.

When this work was completed the pump was again set in motion, and when the gauge indicated 835lb. per square inch ring D collapsed at a point about 20in. from the weld. The bulge extended from flange to flange, and measured 16in. broad by $2\frac{1}{8}$in. deep at the middle of the ring.

The permanent sets found in the tube at the completion of this test are given in Table No. 6 :—

TABLE No. 6.

Distinguishing Letter on Ring.								Increase in Length of Tube.
A.		B.		C.		D.		
Vertically.	Horizontally	Vertically.	Horizontally	Vertically.	Horizontally	Vertically.	Horizontally	
Inch.	Inch.	Inch.	Inch.	Inch.	Inch.	Inch.	Inch.	Inch.
$\frac{1}{16}$ full	Nil.	—	—	$\frac{1}{16}$	Nil.	$2\frac{1}{8}$	$\frac{5}{16}$ full	—

After the sets in the above table were taken, ring D was supported by a cast-iron hoop in a similar manner to ring B, and when pressure was again applied it collapsed a second time with a pressure of 810lb. per square inch. This bulge was located at a point 19in. further from the weld than the previous one, but in character and extent both bulges were practically alike.

At this juncture the number of wedges between the cast-iron hoops and the two disabled rings was doubled, but notwithstanding this precaution ring D again collapsed at a point about 14in. from the bulge last referred to, when the gauges indicated a pressure of 840lb. per square inch. Ring A also collapsed with this pressure, the bulge in it being somewhat similar, as regards character and extent, to those already described.

In order to collapse the remaining ring (C), another cast-iron hoop was put inside of ring A, and wedged like the others. When the pressure again reached 840lb. per square inch, ring C collapsed at a point about 15in. from the weld, and ripped for about $12\frac{1}{2}$in. along the root of the flange by which it was attached to ring B. (See figs. 1 and 2, Plate II.) There was also a secondary rip about 6in. long, which overlapped the primary one, and in a sense might be considered a continuation of it. The character and extent of the bulge were very similar to the others, but owing to the plate failing as described, an opening about 16in. long by 3in. at the widest part was formed, through which the water was ejected with great velocity, seriously injuring Mr. Mollison, Lloyd's senior engineer surveyor in the Glasgow district, who was then at my side watching the behaviour of the tube as the pressure was increased. The metal at the fracture had a crystalline appearance, thus indicating that it had been overheated or otherwise injured in the process of flanging.

The direct crushing stress due to the pressure which a plain welded tube sustains is found by the formula—

$$(1)\quad \frac{D \times P}{2\,T} = S$$

where D = the outside diameter of the tube in inches ;
P = the pressure in lbs. per square inch ;
S = the stress in lbs. per square inch of section of the tube ;
T = the thickness of the tube in inches.

And if this formula be applied to the rings which composed the experimental tube, it will be found, by excluding the flanges and caulking rings from the effective section, that the stress in each case when collapse occurred was that stated in Table No. 7 :—

TABLE No. 7.

Distinguishing Letter on Ring.	Stress (S) per Square Inch of Section of Ring when Collapse occurred.		
	Lbs.		Tons.
A	33,428	=	14·92
B	30,890	=	13·79
C	33,046	=	14·75
D	33,415	=	14·91

(To be continued.)

THE BIRMINGHAM BOILER EXPLOSION.

THE inquest with regard to the recent fatal boiler explosion which occurred at Birmingham was held on Tuesday last, and resulted in a verdict of "Accidental death." From the evidence it appears that the explosion was due to the existence of an old flaw at one of the longitudinal seams of rivets, which from its position could not have been discovered. Full details of the inquiry, accompanied with illustrative sketches, are in course of preparation, and we hope to present them in our next issue.

CORRESPONDENCE.

We do not hold ourselves responsible for the opinions of our Correspondents.

BOILER INCRUSTATION.

To the Editor of "The Practical Engineer."

Sir,—With regard to the letter in your last issue on this subject, it may be of interest to hear what some of our steam-using American cousins are doing. One of the most difficult problems which many of them have to contend with is the formation of scale in the interior of their boilers, and the corrosion due to water impregnated with such minerals as salt and sulphur. In the city of Pittsburgh, where thousands of boilers are driven through the use of natural gas flames to an extent that is unknown elsewhere, and with water containing as much mineral as any water in the country, a remedy has been found in the use of natural oil, free from tar, reduced by distillation until a fire test of 600 deg. F. has been reached, compounded with certain valuable elements which aid in dissolving the scale, and which prevent any tendency towards priming, even where alkali water is used. A quart of this compound, costing about 10 cents, is placed in the boilers after washing out and before filling once a week, and is sufficient to coat the interior of the largest boiler very slightly, like the touch of a perspiring hand on a window pane, but quite sufficient to prevent adhesion of scale. The individual atoms composing the mineral sediment in the boiler take on a slightly greasy nature, and crystallisation or cementation is thereby prevented, and the result is a soft mud, got rid of by blowing out at intervals, and by the usual washings out. In a few weeks after using, the mud-drum, legs, and parts of the boiler not exposed to the greatest heat, will be found coated with the resolvent, while such parts as are over the fire and are subjected to the greatest heat are as clear and bright as new iron. Acids having no effect on petroleum, it follows that the coating of solvent will prevent the corrosion, grooving, and pitting which are so destructive to boilers using acid water.—Yours truly,

Oct. 15th, 1888. B. J. T.

RAILWAY HEROES.

To the Editor of "The Practical Engineer."

Sir,—Everyone, I feel sure, will admire the fearless courage displayed by the unfortunate locomotive driver who was scorched to death by the rush of flame from the firebox, and to which reference was made in your issue of the 5th inst. I think, however, an act of equal devotion to duty, and one equally worthy of record, is that which resulted in the death, in Huddersfield Infirmary a few days ago, of a locomotive driver and a stoker, named Green and Walling respectively. The two men left Leeds on September 27th with the 6-30 p.m. passenger train for Manchester, and had got as far as the Standedge Tunnel, between Marsden and Diggle, when the right-hand connecting rod broke and commenced to whirl round with such a terrific force that it pierced the outer and inner casings of the firebox, and the contents of the boiler were poured through the firehole door, between the two men. Walling escaped to the tender without much hurt, but Green remained on the footplate to manipulate the brakes, to do which he had to cross from side to side of the footplate, through the torrent of fire and steam. He achieved his object; and now the pangs of the fiery stream began to tell upon him, and Walling, hearing the shrieks and moans of his mate, rushed down from his place of comparative security to assist him, and was himself so severely scalded and burned that from the first there was little hope for him. Lawrence Green died in Huddersfield Infirmary on September 30th, and Charles Walling died at the same institution on October 6th. Both men were very highly respected, and their untimely and unfortunately sad end is deeply regretted by all who knew them.—Trusting that you may find a corner for such heroic deeds as these, I am, dear sir, yours truly,

Oct. 16th, 1888. S. Boswell.

QUERIES AND REPLIES.

Sugar Machinery.—If you, or any of your numerous readers, can give me any information about books or pamphlets on the above subject, I shall be very much obliged to you.—Old Finsburian.

Answer.—We are not aware of any book dealing specially with the manufacture of sugar machinery. An interesting series of lectures, however, on sugar manufacture was delivered before the Society of Arts in 1871, by C. Haughton Gill, which may be of interest. These lectures were afterwards published separately in pamphlet form, the price, we believe, being 1s.; but we are not sure whether they are still in print. You could get full information on the point by writing the Secretary, Society of Arts, John Street, Adelphi, W.C.

Flanged Couplings.—Will you kindly, through your columns, give me the proportions of flanged couplings for different sizes of shafts, the diameter of shaft, size and number of bolts, distance from centre, &c., &c.—F. C.

Answer.—You will find full information on the subject in "Unwin's Elements of Machine Design." A short article on the subject also appeared in our issue for May 6th, 1887. See page 139, Vol. I.—Ed.

Strengthening Rings for Manholes in Boiler Shells.—Would some reader kindly give me a rule for calculating the size and section of compensating rings for the piece cut out for manholes, the rings to be inside in one case and outside in the other?—H. L. C.

Answer.—When a hole is cut in a boiler shell or any other cylindrical vessel exposed to internal pressure, the additional stress imposed upon the material on each side of the hole is not evenly distributed over the remaining section of the metal. It is much greater in the part immediately adjoining the hole than at a distance away. That is to say, if the shell be conceived to be made up of a series of narrow belts, then the belt immediately adjacent to the hole would be more surely distressed than the one further away. The exact ratio of the variation of stress is indeterminate, and there is no mathematical rule for determining the proportions of the strengthening ring. The net section of the ring, however, should on no account be less than that of the material cut away; while in first-class practice, it is usual to allow about 20 per cent of excess. Whether the ring be inside or outside makes no difference.—Ed.

Helical Wheels.—Can any of my fellow-readers inform me of the best mode of setting out the teeth of a pair of bevel helical wheels, the larger wheel to be 34·8in. diameter, with 6in. face and 73 teeth, 1½in. pitch, and the smaller one or pinion 18·14in. diameter, with 6in. face and 38 teeth 1½in. pitch? Also a plain spur wheel 77·98in. diameter, with 140 teeth, 1¾in. pitch, to work in a pinion 40·1in. diameter, with 72 teeth. Any information with regard to making the patterns would oblige.—J. W. J.

Would some reader kindly inform me what is the proportionate strength of helical wheels in comparison with spur wheels having similar diameter, pitch, and face; also what is the rule for finding the breaking strength of helical wheels?—W. R. E.

Weighing Machines.—Is there any book published dealing specially with the construction of these machines, and what is the price?—T. D.

Chilled Furnace Bars.—Can any of your readers give me any information with regard to chilled furnace bars? To what depth can they be chilled from the top surface? Is it difficult to cast chilled bars any length—say 6ft.? What difference does it make in the nature, temperature of fusion, and also cost as compared with ordinary furnace bars?—Durability.

Olive Oils.—I should be pleased if any of your readers would furnish me with an easy method for testing the purity of olive oils.—M. Barker.

Hoppers for Grinding Mills.—Having a number of hoppers to make for a grinding mill, I shall be obliged if some reader would give me a rule other than rule of thumb for finding the proper bevil to plane the corners to.—A Country Millwright.

Hydraulic Ram.—Can any reader oblige me with a sketch and rules for proportioning a modern hydraulic ram, such, for instance, as the "Galiban" ram? I have studied the description of the hydraulic ram given in Rankine's "Prime Movers," but the sketch there given is very obscure, and I cannot follow the action of the waste water valve.—Querist.

Firing of Mill Chimney.—A mill chimney, 125ft. high, situated behind three Lancashire boilers and a Green's economiser, "fired" like an ordinary house chimney, after boiler fires were drawn out, dampers shut down close, and the works closed. Do any of your readers know of a similar instance, and can they assist me in preventing a repetition?—L.

A Varying Coal Consumption: Pollitt v. Lancashire Boilers.—We have three of Pollitt's Lancashire boilers, each 7ft. × 30ft., lying alongside a new ordinary Lancashire boiler, 7ft. 6in. × 28ft. One week we fire the three Pollitt's boilers, and the next week two of the Pollitt's with the new Lancashire boiler, having one thus laid off each week. When using the three old boilers our consumption per week is thirty-five tons of coal, but when using two old boilers coupled with the larger new boiler, we burn forty tons per week for exactly the same work and hours. Boiler shells are all covered in alike, and steam pipes coated. The new boiler is nearest the chimney and has the best draught; but why should we burn five tons per week more for the same quantity of steam raised when using it?—Chief Stoker.

TO CORRESPONDENTS.

Vulcan.—On looking at the tracing, we gather that what you mean by length of link is length of eccentric rod. Assuming the tracing shows the slide rod in its central position, then the length of the eccentric rod will be the distance from the centre of what you term the "link pin" to the centre of the shaft, which is marked 10⅛ inches. With regard to the throw of the eccentric, this depends, to some extent, on the amount of "lap" of the slide valve. As we gather from the tracing, however, that the engine is merely a toy, and that the steam is to be kept on throughout the full length of the stroke, the throw of the eccentric will be just equal to the width of the steam port, viz., a quarter of an inch. The total travel of the valve will of course be double this. When you spoke of link motion in the first instance, we thought you might possibly be referring to some form of marine or locomotive reversing gear; but, as already stated, we presume from the tracing that you wish to work the valve direct from the main shaft.

F. W. S.—We are not aware of the existence of any journal specially devoted to pattern making. The book on the subject advertised in our columns is thoroughly practical, and one we can heartily recommend. The contents of the pan, sketch of which is enclosed with your letter, cannot be determined accurately without mathematics. Possibly, however, a solution sufficiently accurate for your purposes could be obtained by regarding the pan as a plain cylinder with a diameter of 19in. and a depth of 12in., the contents of which would be a little less than 2 cubic feet—say 12 gallons.

Stony Stratford.—In the absence of a sketch showing the general arrangement of the vertical tandem engine you refer to, it is difficult to say whether the headway could be reduced. We do not see, however, that you could dispense with the piston gland, or avoid affording the necessary space for access in order to pack it. If the high-pressure cylinder were bolted directly to the end of the low-pressure one, it would be difficult to keep the piston rod steam-tight, and any leakage would seriously militate against economical working.

Young Engineer.—We have not the time to carefully go through and calculate your figures, for that is practically what your inquiry amounts to. We put ourselves to a considerable amount of trouble to try and meet the wants of our readers, but we cannot undertake to act as general consulting engineers. The information you seek would be of little or no interest to any one but yourself, and to satisfy you would make too heavy demands upon our time. Further, we beg to say that we cannot undertake to respond to any inquiries unless the writer furnishes us with his name and address.

I. V.—The "Lessons in Mechanical Drawing" commenced last year. The bound volume for 1887 may be obtained direct, price 6s. 6d. We do not know where you could obtain the book on locomotive building in America, except direct from the publishers referred to in the notice given in our columns. We do not know anything of the paper entitled *The Locomotive Engineer.*

MISCELLANEA.

The Ebbw Vale Strike.—The miners in the Ebbw Vale, who have been on strike for six weeks, have decided to resume work. The coalowners and the representatives of the colliers have agreed that the dispute with regard to wages shall be settled by arbitration.

Manchester Association of Engineers.—This association has just issued the following syllabus of papers for the coming session. October 27th, Mr. Bennion, on "Patents and Patent Law;" November 10th, Mr. F. Ashbury, on "The Forth Bridge;" November 24th, Mr. Bolas, on "Some Types of the Modern Locomotive;" January 26th, 1889, Mr. Alderman Bailey, on "An Early Page in the History of the Liverpool and Manchester Railway;" February 23rd, Mr. C. P. Brooks, on "The Loom;" March 9th, Mr. Dack, on "An Improved Hydraulic Lift."

Accident at the Parkgate Ironworks.—A serious accident occurred the other day at the Parkgate Iron and Steel Works, near Rotherham, by which one man was killed and six were injured. The company are erecting new steelworks, and a dozen men were engaged taking down a travelling crane under a mass of brickwork, when the latter suddenly collapsed and fell outwards where eight men were working at the hand cranes. The manager had just time to step aside and avoid the crash, but several men were buried under the débris. One man was killed on the spot, while six other workmen were more or less severely injured.

A New Railway Wagon.—Two American freight cars, on the Goodfellow and Cushman principle, were recently taken to Barrow with a view to their adoption on British railways. They were brought over from the United States in sections, and were put together in London. These wagons are each 30ft. long, and will carry a load of 30 tons. One of them was satisfactorily tested with 30 tons of steel rails, and the other with 27 tons of coal. The cars are supported at each end by a four-wheeled bogie. The cars are built of steel tubes, and weigh about 10 tons, against 6 tons as in the case of the ordinary railway wagon, but they carry three times the weight. It will be necessary, however, to provide special weighing machines for this class of carriage, as they are too long to be weighed on the ordinary machines. It is proposed to commence the manufacture of these cars at the Vulcan Steel and Forge Works, Barrow.

Energy Expended in Boat Racing.—Professor William P. Trowbridge, of the School of Mines at New York, has been making some examinations upon the expenditure of energy of eight men during one of the college races. The distance, a four-mile course, or 21,120ft., was traversed in 21 minutes, there being a speed of about 1,000ft. per minute. The resistance of the boat at this speed was determined by experiment to be 75lb., and the work per minute for the eight men, therefore, was 75,000 foot pounds, which is ·28 horse power per man; this is seven times the rate which strong labourers are compelled to maintain during a day's work. The conclusion from the investigations is that these extraordinary efforts are excessive in the strain which they place upon the heart and lungs of those engaged, and that races are practically decided at the end of the third mile, and that all prudence requires that the length of course in college boat racing should be reduced at least to that distance.

Messrs. Tangyes, Limited.—This enterprising firm are adding to their already varied list of manufactures a new branch in the shape of separate parts of steam engines, and have just issued a new and elaborate catalogue illustrating the parts they are prepared to supply. The variety of steam engines made by the firm, both as regards design and size, is very great. An indication is afforded by the fact that in the catalogue a list of 58 different steam cylinders is given, varying from 4in. to 32in. in diameter, and from 5in. to 4ft. in stroke. Crank shafts, connecting rods, and other details in like variety and proportion are also offered. Any of these details the firm offer to supply, either in a rough or more or less machined state, from the engine cylinder down to the foundation bolt. This new departure on Messrs. Tangyes' part will, no doubt, be of great convenience to many makers who have not the facilities for the construction of many of the parts of a steam engine, which may form only a small portion of the machine they may be engaged upon.

Refining Sugar by Electricity.—Electricity has been put to such a variety of uses that one is naturally very chary of drawing limits to its applications. The latest use to which we have heard of its being put is the operation of sugar refining. Several samples of sugar refined by an electrical process, the invention of the late Professor Friend, of New York, have been recently sent over for inspection to the Confectioners' Union, 171, Queen Victoria Street, London. The *modus operandi* of the process is not stated, but the refining is said to be carried on in a building in New York five storeys high, the raw sugar being fed into the machine on the top floor and then gradually passing downwards to the lowest floor, where, without having been seen or handled, it is delivered in a refined state. The time occupied in the passage of the sugar from its entry to its exit is four hours. The works are, it is stated, only experimental, but that extensive works on a large scale are about to be erected for the commercial working of the invention.

SELECTED PATENTS.

APPLICATIONS FOR LETTERS PATENT.

October 5th.

14293	Ore Stamp, J. Harris-James, Cornwall.
14300	Trimming or Levelling Coal in Ships, C. Sanders, Bristol
14302	Valve and Hand Motion for Steam Hammers, A. Taylor, Sheffield
14303	Gig Mills, C. Wood, Manchester.
14309	Starting Tramcars, J. Leach and W. V. Hirst, Sheffield.
14310	Air Propeller, F. W. Richardson, West Hartlepool
14313	Velocipedes, C. P. Byrne, London, W., and F. T. Haisman, Hanwell.
14317	Iron Pipe Wrench, J. Frayn and G. H. Goodyear, Plymouth.
14320	Fixing and Securing Boiler Stays, J. C. Park, London
14322	Galvanic Cell or Battery, S. Miller, Chancery Lane, W.C.
14323	Electrolyte Solution, S. Miller, Chancery Lane, W.C.
14324	Recording, Adapted to Anemometers, J. Jordon, jun., London.
14332	Tempering of Steel, H. W. Wallis, London.
14335	Elevators or Lifts, T. P. Ford and W. A. Gibson, Chancery Lane.
14336	Caloric Engine, C. Wells, Chancery Lane, W.C.
14337	Screw Propellers, C. Wells and C. J. R. Stirling, Chancery Lane, W.C
14338	Ventilators, W. Wilkie, London. (J. P. Black, New Zealand.)
14342	Station Gas Governors, J. K. Bartlett, Westminster.—[Complete Specification.]
14347	Monocycle, J. C. Burn, jun., London.
14348	Valve Gear, O. Imray, London.
14349	Igniting Apparatus, C. D. Abel, London.
14350	Derrick and Detail Appliances, E. Towndrow, London.

October 6th.

14357	Riveting Joints of Vessels, W. Skaife, London.
14358	Slow Combustion Stoves, W. Bishop, London.
14359	Friction Clutch Pulleys, W. P. Thompson, Liverpool.—[Complete Specification.]
14361	Boilers, W. H. Wood and A. W. Turner, Birmingham.
14363	Heating Air, &c., B. H. Thwaite and S. Knowles, Manchester.
14374	Steering and Warping, T. M. Grant and A. Kelly, Glasgow.
14381	Valve Gear, A. G. Mumford and J. Dalby, London.
14387	Measuring Liquids, W. Barnes, London.
14388	Brakes, H. K. Toll, London.
14394	Furnaces, W. G. Foster, London.
14401	Engines, C. E. Hearson, Middlesex,

October 8th.

14407	Weighing Machines, M. Settle, Manchester.
14408	Extra Check Valve, A. Jackson, West Hartlepool.
14411	Metallic Wire Asbestos, H. P. Bailey, Newcastle-upon-Tyne.
14415	Circulating of Steam, C. E. Basevi, Cheltenham.
14416	Portable Gas Lamp, H. D. Fitzpatrick and G. Rose, Glasgow.
14418	Automatically Lighting Starlights, &c., A. Ransford, Manchester.
14428	Rim Pulleys, &c., C. W. Maclean and J. R. Hubbard, London.
14432	Furnaces for Heating Steam Boilers, &c., J. Horn, Finsbury, London.
14445	Extraction of Aluminium, P. Marino, London.

October 9th.

14447	Sea-oiling Projectile, A. H. Walker, London.—[Complete Specification.]
14448	Apparatus for Compressing Gas, L. Block, London.—[Complete Specification.]
14450	Double-acting Pump, J. J. Pearson and T. H. Taylor, Newcastle-on-Tyne.
14462	Boring Rudders, &c., P. Robertson, Renfrewshire.
14464	Hydraulic Press, W. S. Shreeve, Warwickshire.
14465	Lamps and Burners, T. Flood, J. H. Flood, and A. A. Dorrington, Manchester.
14474	Circular Saw Plates, W. H. Singer, London.—[Complete Specification.]
14485	Furnaces, J. Sawyer, H. B. Phillips, and W. Mitchell, London.
14488	Sewing Machines, J. Gutmann, London.
14490	Wood-working Machines, E. George, Newcastle-upon-Tyne.
14492	Electrical Signalling Apparatus, J. B. Sutherland, London.—[Complete Specification.]
14493	Wheels, J. Munton, London.—[Complete Specification.]
14495	Axle Boxes, W. C. Abell, Middlesex.
14497	Straightening Shafts, W. A. McCool, London.
14511	Mining Drills, W. H. Jenkins, London.—[Complete Specification.]
14513	Driving Gear, A. F. Wileman, London.
14515	Pipe Joints, J. Latta, London.
14516	Thermometers, H. A. Hotblack, London.
14517	Drawing of Metals, W. A. McCool, London.
14520	Screw Propellers, W. Gardiner, Clapton.
14525	Tools, J. Hooper and T. Clark, London.—[Complete Specification.]
14530	High-pressure Water, E. S. Prentice, London.
14531	Rolling and Drawing Mills, C. M. Linley and J. Biggs, London.

October 10th.

14536	Moulds, E. W. Stead, London.
14552	Automatic Fog Signals, E. Holt, Radcliffe.
14565	Switch Boxes, R. C. Rapier, Westminster.—[Complete Specification.]
14572	Screw-cutting Stock, G. Warsop and W. Horsfield, London.
14575	Coke Ovens, H. H. Leigh, Middlesex.
14582	Furnaces, C. Allen, J. Clark, and W. G. Dickson, London.

October 11th.

14590	Propelling Ships, J. H. Milne, Glasgow.—[Complete Specification.]
14597	Annealing and Drawing Wire, A. W. Brewtnall, Manchester.
14599	Incrustation in Boilers, S. Binks, Halifax.
14602	Breech Mechanism, J. Fielding, Gloucester.
14603	Manufacture of Paper, &c., A. B. Webb and J. Watson, Manchester.
14605	Pulleys or Sheaves, A. Higginson, Liverpool.
14611	Electric Railway, J. Monteith, Glasgow.
14614	Heat Engines, E. R. Royston, London.
14616	Centrifugal Pumps, M. Hecking, London.
14628	Water Taps, W. Shelley, London.
14629	Internal Covering for Corrugated Metal Roofing, W. Lorenz, London.
14632	Cutting Oval or Circular Holes, A. Blechynden, London.
14636	Pulleys and Drums, A. B. Perkins, London.
14637	Railway Signals, S. T. Dutton and H. J. Pryce, London.
14638	Gas Meters, C. Willson and G. Roberts, Grimsby.
14640	Steam Engines, H. Grafton, London.
14641	Rapid-firing Guns, J. Rogerson and A. Downie, London.
14643	Boilers, I. S. McDougall and J. T. McDougall, London.
14646	Anchors, H. P. Parks and J. Hartness, Middlesex.

PUBLISHERS' ANNOUNCEMENTS.

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EDITORIAL NOTICES.

All communications for the Editor of this Journal should be addressed to 6, Victoria Station Approach, Manchester.

Communications intended for insertion in the current week's issue should reach us not later than Tuesday Evening.

We cannot undertake to return rejected manuscripts or drawings unless accompanied by a stamped and directed envelope.

Contributors are requested to write on one side only of the paper. Sketches should be sent on separate sheets.

TO ADVERTISERS.

Advertisements intended for insertion in the current issue should reach us on Wednesday morning at the latest.

THE
PRACTICAL ENGINEER.
OCTOBER 26TH, 1888.

PATENTS FOR INVENTIONS.

THE tendency of recent legislation with reference to patents has been, up to the present, in the direction of freeing inventors from vexatious restrictions and heavy fees. Now, however, there is a movement on foot with a view to establishing a "closed" profession among patent agents, which cannot possibly result in anything but increased cost to those requiring the agent's services, as well as introducing an unnecessary and unjustifiable limit to the selection of the agent. The Act of 1883 put inventors in such a position that anyone understanding ordinary English could draw up a specification, with the certainty that the law would uphold anything new that he had described. But some inventors, not having sufficient confidence in themselves, call in the services of a friend to assist them, and, as the actual filing of the specification is done in London, preferably communicate with those residing there, especially if the inventor lives in the country. Under such circumstances, too, it is not infrequently arranged that the London man shall receive the usual notices from the Patent Office, and he consequently practically becomes a patent agent for his friend in the country. The aim of the new Act is to prevent any such transaction, even if the agent friend receives no compensation for his services, for the proposed enactment will impose a penalty of £20 on anyone acting as agent to an inventor if not previously registered as such. To be registered as a patent agent, it will only be necessary to prove being in practice previous to July 1st, 1887, so that, no matter how elementary the patent agent's knowledge, no matter how incompetent to do the work required, the mere fact of having done agency work in a sufficiently public manner prior to this date will gain entrance to the charmed circle to be formed.

As in all other professions, there are "patent agents" and "patent agents"—good, bad, and indifferent. The good ones need no defence or closed union, and it is doubtful if they uphold this new departure. Their business is carried on by men who are technically trained to its requirements, both practically and legally, and their services are as highly valued as their fees are readily paid by those who ask for their assistance. The less respectable class of agent will gain nothing by advocating a trades union such as described, for the public will naturally only gauge their incompetence by the persistence and noise with which they attempt to bring it about. It is unfortunate for the satisfactory result of the controversy now pending in this matter that due allowance is not made for the fact that a patent agent is only an agent after all, and the client in many cases will not be ruled by the excellent advice often tendered him by his agent. Who has not heard of the oft-repeated case of the patenting, through an agent, of a corrugated piston, with the object of obtaining a greater effective piston area than with a plain one in the same-sized cylinder? But we have not heard the agent's version of the affair. It is not breaking faith to give a more recent case, now preparing for filing, in which an inventor is going in for nothing short of perpetual motion, in spite of the very decided opinion expressed by the agent. Of course, it will be argued that in such cases an agent should throw the case up, and not have his name tarnished by any such questionable association. But the fact that if one agent will not do it another will, and that if kept by the first agent constant judicious reasoning and explanation may ultimately be the means of convincing the inventor of his fallacy, or at any rate cause him to reduce the more flagrant absurdities of the idea, so that those who peruse it may not be too much impressed, influences an agent very strongly in favour of the retention of the case, although he might serve his own interests better by declining to have anything to do with it.

But these considerations are only duly taken into account by the better class of agents. Those who send round circulars couched in much the same terms as the quack doctor's, and containing the usual inuendo that every other firm but their's is a bogus one, are not influenced in the least by such trifles, and they consider that, as all is fish that comes to the net, they have only to do their client's bidding and pocket the remuneration. It is a pity that some of the larger and higher-priced firms of agents are not as free from blame in this matter as they should be; for, though they do not descend to the palpably unscrupulous proceedings of some of their brethren, they not infrequently appear to take so little interest in an inventor's case as to miss entirely the novel points put forward, or else claim something that is purposely omitted from the instructions, and consequently cause the inventor to fall back on his own resources and draw and file the specification himself. The drawings, too, are often a sore point, and in many cases are but bad copies of originals provided by the inventor to prevent a recurrence of previous trouble.

No doubt agents get blamed for a great deal that is not their fault, for the instructions received are oft-times of the most meagre and indefinite kind. But the Patent Office officials themselves appear to have gone out of their way to suggest, or in some cases actually make, alterations in specifications drawn as carefully and as clearly as possible. But for the large amount of trouble they have caused themselves and the public it is doubtful whether the new idea of a closed profession would have received the support it has. It looks very much indeed as though the rulers in Southampton Buildings were anxious to shift some of their responsibilities and their results to the shoulders of the agents, on the principle that one good turn deserves another; and, in return for the agent being hedged round with a snug little legally-constituted union, he will have to take the possibility of the odium previously attached to the proceedings of the officials.

The amendment to the Patent Act referred to above is to be introduced in November. In the meantime the engineering world appears to be getting ready to try conclusions with the promoters, and it is greatly to be hoped that such an audacious proposal will not be allowed to become law without very cogent reasons being put forward for its absolute necessity.

In all seriousness, this attempt to create a closed profession of patent agents will bring discredit not only upon the promoters, but also upon the Government officials leagued with them. Should it prove successful, it will constitute a direct interference with the free choice of an agent, and raise an unjustifiable barrier to the admission into that profession of any not over-wealthy, but otherwise perfectly competent, candidate.

King's College Engineering Society.—At a general meeting of this society, held on Oct. 16th, Mr. C. E. Jones delivered his Presidential Address, taking "Gold Mining" for his subject. He confined his attention chiefly to the Australian gold fields, and commenced by enumerating the principal forms in which the metal is found, viz., as alluvial gold associated with river mud, sands, and gravels, and in quartz reefs. In these cases it may be associated with nearly every other known metal, but it is generally believed that the gold is never found in combination with them, but is merely mechanically associated; while a few hold that it exists as a culphide in some varieties of pyrites. The author then dwelt on its geological distribution, and touched on its occurrence in England and Mr. Pritchard Morgan's Welsh workings. He went on to describe the various processes for extracting the metal, from the old cradle to the latest chlorination processes. After a vote of thanks to Mr. Jones the meeting adjourned.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.

Visit to the Hartlepools.

Following the example of other technical institutions, the Council of the North-East Coast Institution of Engineers and Shipbuilders made arrangements for a visit to the Hartlepools. From time to time a desire had been expressed to spread the ramifications of the society, and to increase the interest in its operations amongst shipbuilders and engineers who are at a distance from Newcastle-on-Tyne. As is well known, those on the river Wear are kept in touch by meetings of the institution being frequently held in Sunderland, but there is now reason to believe visits on Saturday afternoons to the leading establishments of the iron and steel industries will become a regular portion of the ordinary proceedings. Hartlepool has set the example by freely giving access to even the private drawing offices, &c., of the shipbuilding yards, and the Tees, Wear, and Tyne cannot long refuse to return the compliment. If an annual outing of this kind be not arranged, at least a biennial one should be assured.

Possibly there was a feeling amongst most of the visitors that nothing could be learnt at Hartlepool—but if so, this idea was speedily dispelled. The ports are chock full of activity, and in our limited space it is difficult to know what to particularise and what to omit. As might be expected, all the visitors could not overtake the entire programme, which had been carefully prepared by Mr. Duckett, the secretary, in conjunction with Mr. Fothergill, of forced draught renown. The West Hartlepool Steel and Iron Company's works received the least attention, although equipped with new plant for steel manufacture, comprising six 20-ton Siemens furnaces, with sixteen Ingham gas producers, &c. Most of the visitors, however, found time for an inspection of the new central shipbuilding yard of Messrs. W. Gray and Co., the site of which, in January last, was covered by ballast heaps, but is now occupied by a large collection of the most modern shipbuilding appliances, and by three large steamers, one of which is in such an advanced stage of progress as to be intended to be launched in November. It is specially noteworthy that the punching, shearing, bending, and planing machines have all been selected so as to be capable of efficiently manipulating plates of 30ft. length and 7ft. width, labour-saving being specially considered.

To avoid the unnecessary turning of shell plates, &c., the punching and shearing machines are in some instances provided with punches, or shears, on all four sides. White's patent beam and angle-planing machine, manufactured by Messrs. Scriven and Co., Leeds, has also found a place. Hydraulic riveting is used on all frame and beam work, although, instead of employing portable riveters on the frames, reverse frames, and floors, ordinary fixed riveters are in use, the portable form of riveter being solely used on beams. Provision is being made for lighting the entire establishment with the electric light, which has been long in use at the old shipbuilding yard of Messrs. W. Gray and Co. Here the time available was limited, the point of special interest being a recently placed cold bending Keel plate-bending machine, which was put in operation for the visitors' delectation.

The Central Marine Engineering Works had also their quota of visitors, but less interest was displayed in them, as their construction and equipment have been so fully described in the mechanical press. Greater interest was taken in the Hartlepool engine works of Messrs. T. Richardson and Sons, as recently they have received considerable additions both of shop room and machinery. Amongst the latter is a crank shaft lathe by Messrs. Thos. Shanks and Co., which is 30ft. between centres, and is capable of turning a diameter of 12ft.; also a vertical and horizontal planing machine by the same makers, capable of planing a surface 18ft. 6in. high and 20ft. in length, and a large horizontal boring and milling machine by Messrs. Campbells and Hunter, of Leeds. Messrs. T. Richardson and Sons, besides turning out marine engines, are also supplying customers with castings and forgings, the output of their foundry being 4,800 tons per annum. A number of sets of triple-expansion engines were seen in various stages of progress, as well as upwards of 20 boilers, favourable criticism being in most instances evoked. Messrs. Edward Withy and Co.'s shipbuilding yard did not escape the notice of many of the leading visitors, this firm being well known for its specialty, "the improved well decker," declared at the subsequent dinner, by Mr. B. Martell, chief surveyor of Lloyd's Register, to be the safest type of shipping that floated on the ocean.

It need not be said that justice was done to the dinner after the arduous labours of the afternoon. The whole visit was a success, including the subsequent meeting of the institution, at which Ald. John Price, Mayor of Jarrow, read a paper on "The use of machinery in construction." Although the after discussion was somewhat desultory, the speeches were brief and interesting, but pressure on our space precludes further notice in the present issue.

PRACTICAL NOTES ON MARINE ENGINEERING.—XVI.

(*Continued from page* 255.)

Screw Propellers.

It is a matter of wide difference of opinion among engineers as to what period of the work the dimensions and proportions of the propeller should be considered. Some design the engine throughout, and then, as it were as an after consideration, fix the diameter, &c., of the propeller. This is, however, a very empirical way of working, and the result is only too often brought forcibly before those whom it most concerns. Where designers are not hampered in any way, but are left entirely free, and have scope for putting into practice some of the lessons taught by those who have given this part of the machinery great consideration—in many instances by protracted and costly experiments—they are generally rewarded with success. Whatever other faults and failings they may have, our Admiralty authorities take the first place among those who have paid special attention to this; but while their trials are exceedingly useful and interesting, their practice cannot be taken up and followed in the merchant service. They have, however, led the way—especially as regards the adoption of twin screws—and have, in many instances, been highly successful. The researches of Froude, the experiments of Yarrow and Thorneycroft, are also exhaustive and instructive. No great length of time has elapsed since the first application of the screw propeller. In that excellent work on "Steam and Steam Navigation," by John Scott Russell, bearing the date 1841, no mention is made of a screw, except as follows: "In fact, after experiments of all sorts of oars, propellers, paddles, chaplets, screws, &c., the common paddle-wheel continues to predominate as 'the propeller.'" Though the radial paddle-wheel appears to have been introduced about 1812, it was not until 1836 that a form of screw was introduced. At that time it was a single-threaded Archimedean screw; afterwards a double thread, forming only a portion of a convolution, was tried, and so on to three and four threads, until the present form was finally adopted.

Among the best known propellers, and the one which has perhaps been most applied, is the Griffiths, which consists of a central hub, or boss, on to which the blades are bolted. The Hirsch screw is also well known, and differs from the Griffiths principally in the shape of the blades and the increase of the pitch in the direction of their length. The Mangin screw consisted of two blades set one behind the other, and was experimented upon by the Admiralty in 1878. An arrangement invented by Kemstadter consists of having two screws, one in the ordinary position, and the other outside of the rudder, and attached to the main shaft by means of a Hook's joint at the rudder post. The centre of the rudder was enlarged, and formed a bearing for the outer part of the shaft, so that when the rudder moved over in the ordinary way to steer the ship, the outer propeller moved with it. The main object was to facilitate the turning and manœuvring of the vessel; but there were practical difficulties attending the working of the joint which acted greatly against its introduction. The idea, however, has its merits, and may yet overcome the difficulties at present existing.

The Mallory Propeller.—The De Bay and many other devices, among which may be mentioned the feathering screw, have been tried, but it is not our intention to refer to the numerous ideas that have from time to time entered into the history of marine screw propulsion; we propose rather to speak of the propeller as it is, its shape and proportions as usually adopted in the merchant service.

It does not appear that any definite rule has been laid down for the best diameter of a screw, except that it should be less than the draught of water, but this only refers to the maximum diameter. To make the diameter about four times the stroke of the engine is a common way of fixing this dimension; but it would appear that in many cases the propeller can be made of less diameter than this, and that other matters should enter into the calculation.

The oft-quoted case of the Iris is kept before us wherever this subject crops up, to remind us what can be done by giving due consideration to the proportions of the propellers and their relation to the speed and form of the ship.

In a course of lectures delivered at the Royal Naval College, Greenwich, in 1885, by Mr. Sydney Barnaby, he gave the result of experiments on a small launch, with a three-bladed Thorneycroft screw. The speed, revolutions of propeller, &c., were very carefully noted, and from the result of observations two curves were plotted, one for diameter and one for revolutions. The lecturer evidently intended these investigations to apply under all ordinary conditions, as he refers them to both small and large vessels—the one a first-class torpedo boat, with a propeller 54in. diameter and 430 horse power; the other the twin screw Iris before-mentioned, with propellers 16ft. diameter, and each 3,867 horse power.

Mr. Barnaby's researches are exceedingly instructive, and the difficulty of laying down any hard and fast rule on this subject for the guidance of designers is well illustrated by the examples we have taken from the curves drawn by the lecturer.

"To find the diameter, multiply the diameter found on the curve by the square root of the given horse power. To find the revolutions, divide the revolutions found on the curve by the square root of the given horse-power."

It will be seen how very soon the diameters and revolutions pass beyond the limits of anything yet attempted, though for high speeds, say 15 to 20 knots, with moderate horse powers, the results appear to be practicable.

Taking the first column at 10 knots, the large diameter of 20ft. is reached, with a little over 1,000 horse power, and the revolutions are only 50; while for 20 knots and 100 horse power, the diameter is 2ft. 1½in., with 940 revolutions per minute.

Multipliers from Mr. Barnaby's Curve.

Knots per hour..........	10	11	12	13	14	15	16	17	18	19	20	21
Multipliers for diameter.	7·3	6·25	5·5	4·8	4·35	3·9	3·56	3·25	3·0	2·75	2·55	2·35
Multipliers for revolution	1650	2060	2560	3180	3750	4500	5350	6320	7250	8330	9400	10650

The use of this table, however, lies in the lessons to be learnt from it. It shows that the diameter of the propeller varies as some function of the horse power, and inversely as some function of the speed; and that the revolutions are proportional to the speed and inversely proportional to the diameter.

Now, what the exact relations of these really are is yet a matter of conjecture, and to formulate an expression which would at once be reliable within certain limits, even though empirical in its nature, but yet based on the result of successful practice, is what is wanted.

The different points to be considered in the design of a propeller are—the diameter, the pitch, the surface, the form, strength, number, and material of the blades.

1. The diameter is considered relatively to the draught of water, and should always be less than that.

We have given in the following Table, No. 1, the diameters of propellers suitable for merchant steamers, based on the dimensions of some which have been successful, and have found that the diameter of propeller may be proportional to the square root of the indicated horse power, and inversely proportional to the cube root of the speed and estimated form of vessels. In taking the latter into consideration, it is assumed that vessels of slow speed, say from 9 to 11 knots, will have a co-efficient of fineness about ·75; while from 12 to 13 knots will have ·7, 14 to 15 about ·65, 16 to 17 about ·6, 18 to 19 about ·55, and from 20 to 21 about ·5.

Table No. 1.

PROPELLERS.—DIAMETERS.

Knots per hr.	9	10	11	12	13	14	15	16	17	18	19	20	21
Assumed Co-efficient.	·75	·75	·75	·7	·7	·65	·65	·6	·6	·55	·55	·5	·5
$\sqrt{\frac{s}{c}}$ =	2·28	2·35	2·45	2·5	2·66	2·78	2·8	3·0	3·0	3·05	3·26	3·42	3·47
100 IHP Dia=	4·3	4·2	4·1	3·9	3·8	3·6	3·5	3·3	3·2	3·1	3·0	2·9	2·8
200 ,, ,, =	6·2	6·0	5·8	5·5	5·3	5·0	4·9	4·7	4·6	4·4	4·3	4·1	4·0
300 ,, ,, =	7·5	7·3	7·0	6·8	6·5	6·2	6·0	5·7	5·6	5·4	5·3	5·1	5·0
400 ,, ,, =	8·7	8·5	8·2	8·0	7·5	7·2	7·0	6·6	6·5	6·2	6·1	5·9	5·7
500 ,, ,, =	9·7	9·5	9·1	8·8	8·4	8·0	7·8	7·4	7·3	7·0	6·8	6·5	6·4
750 ,, ,, =	12·0	11·6	11·2	10·2	10·3	9·8	9·6	9·1	8·9	8·5	8·4	8 0	7·8
1000 ,, ,, =	13·8	13·5	13·0	12·5	12·0	11·3	11·1	10·5	10·4	10·0	9·7	9·2	9·0
1250 ,, ,, =	15·5	15·0	14·5	14·0	13·3	12·7	12·4	11·7	11·6	11·0	10·8	10·3	10·1
1500 ,, ,, =	17·0	16·4	15·8	15·2	14·6	14·0	13·6	12·9	12·7	12·0	11·9	11·3	11·1
1750 ,, ,, =	18·3	17·8	17·1	16·5	15·7	15·0	14·7	13·9	13·7	13·0	12·8	12·2	12·0
2000 ,, ,, =	19·6	19·0	18·3	17·7	16·8	16·1	15·7	14·9	14·7	14·0	13·7	13·0	12·8
2500 ,, ,, =	21·8	21·2	20·4	20·0	19·0	18·0	17·6	16·6	16·4	15·6	15·3	14·6	14·3
3000 ,, ,, =	..	..	..	..	20·5	20·0	19·5	18·3	18·0	17·0	16·8	16 0	15·7
4000 ,, ,, =	..	..	..	..	..	..	22·3	21·1	20·8	19·7	19·4	18·5	18·2
5000 ,, ,, =	..	..	..	..	..	..	..	..	..	22·0	21·7	20·6	20·4
6000 ,, ,, =	..	..	..	..	..	..	..	..	..	..	..	22·6	22·3

$$\text{Diameter} = \frac{\sqrt{\text{H.P}}}{\sqrt[3]{\frac{s}{c}}}.$$

Where H.P. = indicated horse power.
S = speed in knots per hour.
C = co-efficient of fineness.

In these ratios even the large diameters soon get beyond the limit of ordinary practice, and about 20ft. for a moderate speed over 2,000 I.H.P. will in most cases be found quite large enough.

The minimum diameter is much more difficult to arrive at than the maximum, as in the latter case the draught of water always fixes it. Independent of every other consideration, the blades should not be allowed to break the water, and so the larger diameter might have to be reduced in order that the screw may be completely covered. Until the limit is reached the diameters found in practice are, generally speaking, somewhat larger than those given in the table, though many highly efficient propellers are much less. It would therefore appear that the prevailing idea to make the screw as large as possible is not a correct one.

(To be continued.)

LESSONS IN MECHANICAL DRAWING.—XXIII.

By Prof. A. MacLay, B.Sc., C.E.

EXERCISES ON GEOMETRICAL LOCI AND POINT PATHS *(continued)*.

INVOLUTE AND EVOLUTE.

In Lesson XIX., Ex. 93, the involute of a curve was defined as the path of the extremity of an inextensible string, which unwinds tangentially from that curve as a base, and moves in its plane. In connection with the following exercises, it should be noted here, as the converse of the foregoing, that if any curve be given as an involute, we can determine the curve from which it has been drawn, viz., its base curve, or, as it is termed correlatively, its *evolute.* Thus, for example, referring to fig. 106, p. 367, with a circle given as base, we obtained the curve PP_1P_2, &c., as its involute. Conversely, if the curve PP_1P_2, &c., had been given, we could, by working backwards, have found the circle from which it was derived. For the involute we drew tangents to the circle; conversely, for the circle we would have to draw the same lines as normals (*i.e.*, perpendiculars) to the curve. Further, the tangent length would now fall to be considered as a *radius of curvature;* and, in short, the base circle is now the locus of the *centres of curvature.*

And what applies to the circle and its involute applies equally to any curve. For, if on any curve we take three points, we can always find the centre of a circle which passes through them. The nearer the points are taken together, the closer will the circle approximate to the curve. The *circle of curvature* is defined as that which passes through the three points when they approach infinitely near to each other, *i e.*, when they coincide. If a point, instead of being a geometrical abstraction (viz., that which has position but not magnitude), were a material particle or a molecule, we would say that the circle which passes through the three points, when they are absolutely contiguous, is the circle of curvature at the middle point.

For any curve then, some other curve can be found, which is the locus of the centres of its circles of curvature from point to point. That other curve is the *evolute* of the first.

From the foregoing it will be seen that we may consider any curve in a twofold relationship:—

(*a*) As an evolute, *i.e.*, as the base of a second curve, which is its involute.

(*b*) As an involute, *i.e.*, as itself the involute of a third curve, which is its base or evolute.

In the following exercises, then, the given curve is to be taken—

(*a*) As an evolute, from which to obtain an involute.

(*b*) As an involute from which to obtain the corresponding evolute.

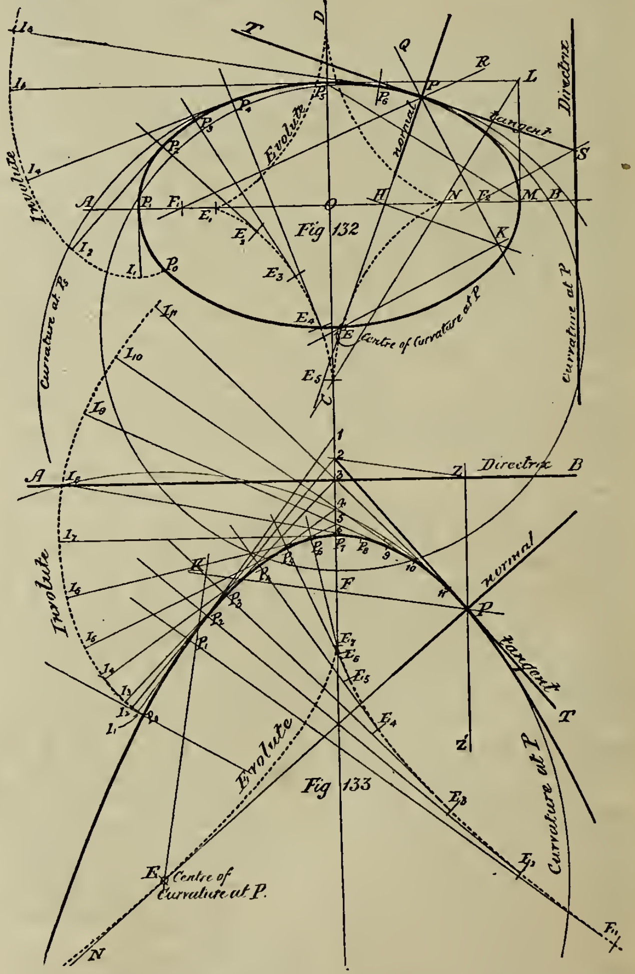
The constructions are all based upon the same principle, viz., for the involutes it is required to find a series of *tangents* to the given curve, and to make them equal to the arc lengths from the initial point; and for the evolutes it is required to draw a series of *normals* to the given curve, and on each of these to make a construction for finding the centre of curvature.

EXERCISES.

Ex. 143.—A curve line passes through the extremities of all tangents drawn to a circle of 1·5 radius, the length of each tangent from its point of contact being equal to the arc of the circle included between that point and another fixed point A on the circumference; the curve to be continued to the diameter produced through A. (1869.)

The evolute of the circle is its centre.

Ex. 144, Fig. 132.—Given an ellipse, *e.g.*, that described in Ex. 111, p. 437, draw (*a*) the involute of one half of the curve, (*b*) its complete evolute.



(*a*) At a series of points P_1, P_2, P_3, &c., on the ellipse, draw tangents to it and measure off on them the arc lengths from the initial point P_0, after the manner described in Ex. 93, p. 368, for the involute of the cycloid. The construction for the tangent at any point P on the ellipse is as follows: From the foci F_1 and F_2 draw the focal distances F_1P and F_2P, and produce them indefinitely to Q and R. Bisect either of the angles F_1PQ or F_2PR. SPT, the bisection line, is the tangent. Otherwise, if the directrix, corresponding to F_2, as focus be given, draw $F_2S \perp PF_2$* intersecting the directrix at S, which is a point on the tangent through P.

(*b*) 1. At a series of points P_1, P_2, P_3, &c., on the ellipse, draw normals to the curve. The normal at any point P is the bisection line PHE of the focal angle F_1PF_2; or having first obtained the tangent at P, draw PHE perpendicular to it.

2. Find the centre of curvature for each point on the curve through which normals have been drawn. The curve traced through the points so found is the required evolute.

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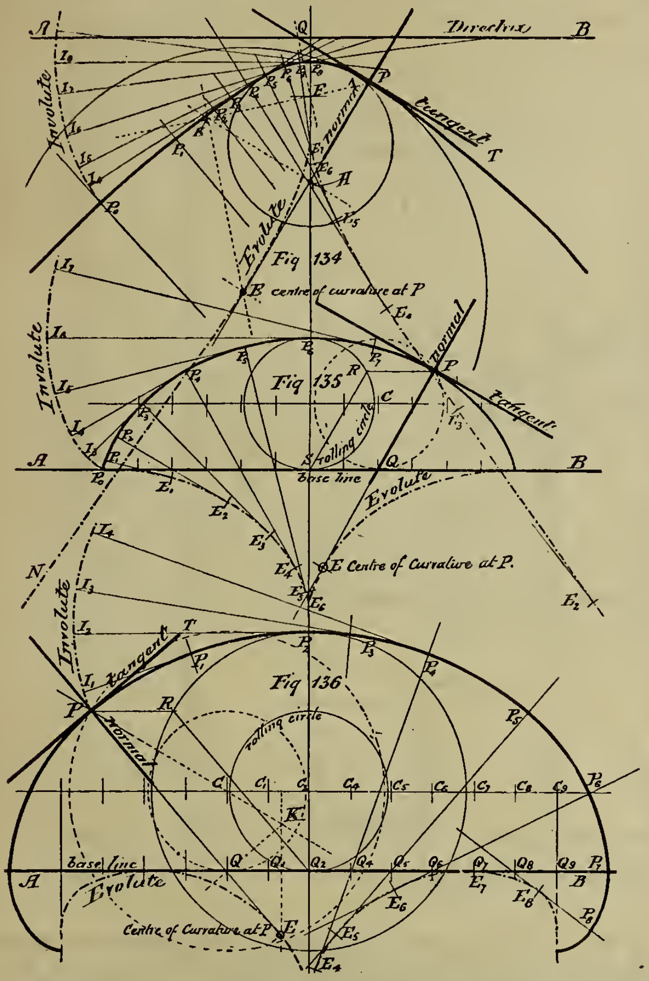
* ⊥ perpendicular to; ∥ parallel to.

The construction for the centre of curvative at any point P on an ellipse is as follows: From H, the point where the normal intersects the major axis, draw a perpendicular to meet the line from P through either focus, at K. Then draw KE ⊥ PK, intersecting the normal at E. E is the centre of the circle of curvature, which passes through P. For the centre at M, join P_5M and draw ML ∥ OP_5 and P_5L ∥ OM. A line from L ⊥ P_5M cuts the major axis at N and the minor axis at E_5. N is the centre of curvature at M, and E_5 that at P_5.

Ex. 145.—Given the parabola of Ex. 77, p. 248, draw the involute and evolute of that part of the curve which lies between two points 3in. from the vertex on each side of the axis.

(*a*) For the tangent at any point P the construction is as follows: Set out from the focus F a distance F2 = FP. The line through 2 and P is the tangent. Otherwise, join PF, and draw PZ ⊥ AB. The tangent is the bisection line of the angle FPZ. The point 2 for the tangent could also have been obtained by drawing Z2 ∥ PF.



(*b*) For the normal at P bisect the focal angle FPZ^1 (the second focus being considered as at an infinite distance from the first, we draw PZ^1 ∥ axis), or draw PN ⊥ PT. For the centre of curvature, produce PF to K, making FK = FP and draw KE ⊥ KP, cutting the normal at E. E is the centre of the circle of curvature which passes through P.

Ex. 146.—Given the hyperbola of Ex. 90, p. 308, draw the involute and the evolute for that part of the curve which lies between the two points, 2″ from the vertex on each side of the axis.

(*a*) Construction for tangent at any point P. Join P to the focus F. Draw FQ ⊥ FP cutting directrix AB at Q. QPT is the tangent.

(*b*) For the normal at P draw PN ⊥ PT.

The construction for finding the centre of curvature at any point P is as follows: From H, the point in which the normal intersects the axis, draw HK ⊥ HP meeting PF produced at K. From K draw KE ⊥ KP intersecting the normal at E. E is the centre of the circle of curvature at P.

Ex. 147, Fig. 135.—Draw the cycloid described by a point on a rolling circle of 1·40″ diameter. Then show its complete involute and evolute.

The constructions for the tangent and normal of the cycloid were described in connection with Ex. 93, p. 368. Referring to fig. 135, PQ is the normal at P, Q being the point of contact of the describing circle (which passes this P), and the base line AB. The normal may also be obtained by drawing PR ∥ AB, meeting the central position of the rolling circle at R. Join R to S, its point of contact. Then PQ ∥ RS is the required normal.

For the centre of curvature at P, produce PQ to E, making QE = QP. E is the required centre.

Ex. 148.—Given the epicycloid of Ex. 94b, p. 368, draw the involute of half the curve and the evolute of the whole curve.

The tangent and normal are obtained in a similar manner to those of the cycloid. For the centre of curvature, however, the construction is similar to that shown in fig. 136. If C is the centre, and Q the point of contact of the rolling circle passing through P, draw QK ⊥ PQ meeting PC produced in K. Then draw KE towards O, the centre of the guiding circle, intersecting the normal at E, which is the required centre.

Ex. 149, Fig. 136.—Given the curtate trochoid of Ex. 133, p. 477, draw the involute of half the curve and the evolute of the whole, *i.e.*, of the curve described by a point on the outer circle, during one turn of the rolling circle.

The normal at any point P is the line passing through Q, the point of contact of the rolling circle and the base line; or draw PR ∥ AB, meeting the central position of the rolling circle at R. Join R and Q_2, the central point of contact. Then PQE ∥ RQ_2 is the normal at P. For the tangent at P, draw PT ⊥ PE.

The construction for the centre of curvature is made as follows: Draw PK through C, which is the centre of the rolling circle when Q is the point of contact. From Q draw QK ⊥ PE, meeting PC produced in K. Lastly, draw KE ⊥ AB. E is the centre of the circle of curvature passing through the point P.

Ex. 150.—Given the curtate epitrochoid of Ex. 135, draw the involute and evolute of the curve described during one turn of the rolling circle.

The tangent, normal, and centre of curvature are found by methods similar to those in the last two questions.

THE BIRMINGHAM BOILER EXPLOSION.

As we briefly recorded in our last issue, the inquest on the above explosion was concluded on Tuesday, the 16th inst., and we now have pleasure in laying before our readers full details with regard to the construction of the boiler and the cause of the explosion, accompanied with illustrations.

The explosion, as already reported, occurred at 10 a.m. on Saturday, the 29th ult., at the flour mill of Messrs. Watson, Todd, and Watson, Vincent Street, Birmingham, and resulted in the death of four persons and serious injury to several others.

The boiler from which the explosion arose was the left-hand one in a group of four set side by side. It was of the ordinary two-flued Lancashire type, and measured 26ft. 8in. in length by 6ft. 6in. diameter in the shell, and 2ft. 6in. in the furnace tubes. The thickness of the plates in the shell was $\frac{7}{16}$in., in the furnace tubes $\frac{3}{8}$in., and in the flat ends $\frac{9}{16}$in. The flat ends were strengthened with three gussets at each end above the furnace tubes, in addition to two longitudinal bolt stays; while there was also a single central gusset at the back end below the tubes. Each flue tube was also fitted with four cross water pipes. The boiler had the usual complement of fittings, including two lever safety valves, loaded to 60lb. on the inch, and also a dial pressure gauge.

The general construction of the boiler will be readily apprehended by a reference to the accompanying illustration, fig. 1. It was made by Messrs. Norman, of Glasgow, in 1876, and had since been periodically examined by the inspectors of the Boiler Insurance and Steam Power Company, Manchester, with whom all the boilers were insured. It appears to have been well taken care of, and everything, apparently, was at work in the ordinary way when the explosion occurred without a moment's warning.

The boiler gave way in the external shell. From an examination of the fractures there can be little doubt that the primary rupture occurred in the first instance at a longitudinal seam at the bottom of the second belt of plating, the rent running from rivet hole to rivet hole through the inner overlap, and extending across the entire width of the belt. From this rent other circumferential ones started, which ran in a more or less irregular manner completely round the shell, cutting out the third and fourth as well as a portion of the second belts from the remainder of the

THE BIRMINGHAM BOILER EXPLOSION.

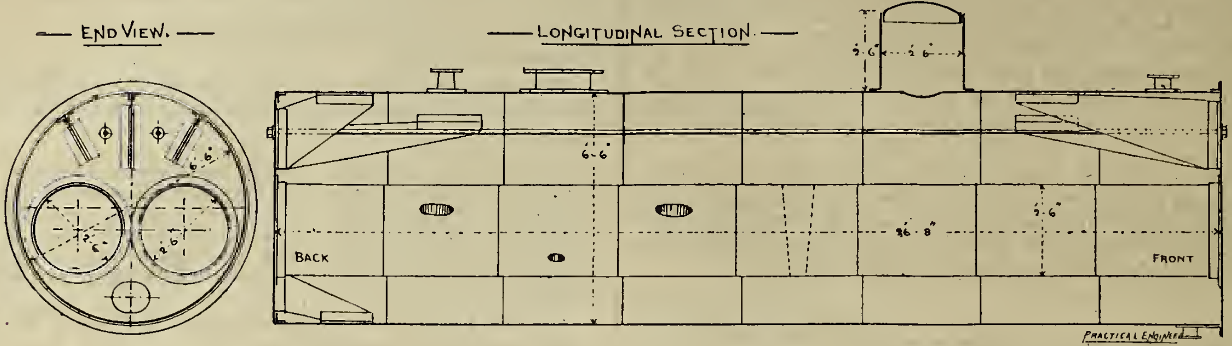


Fig. 1.

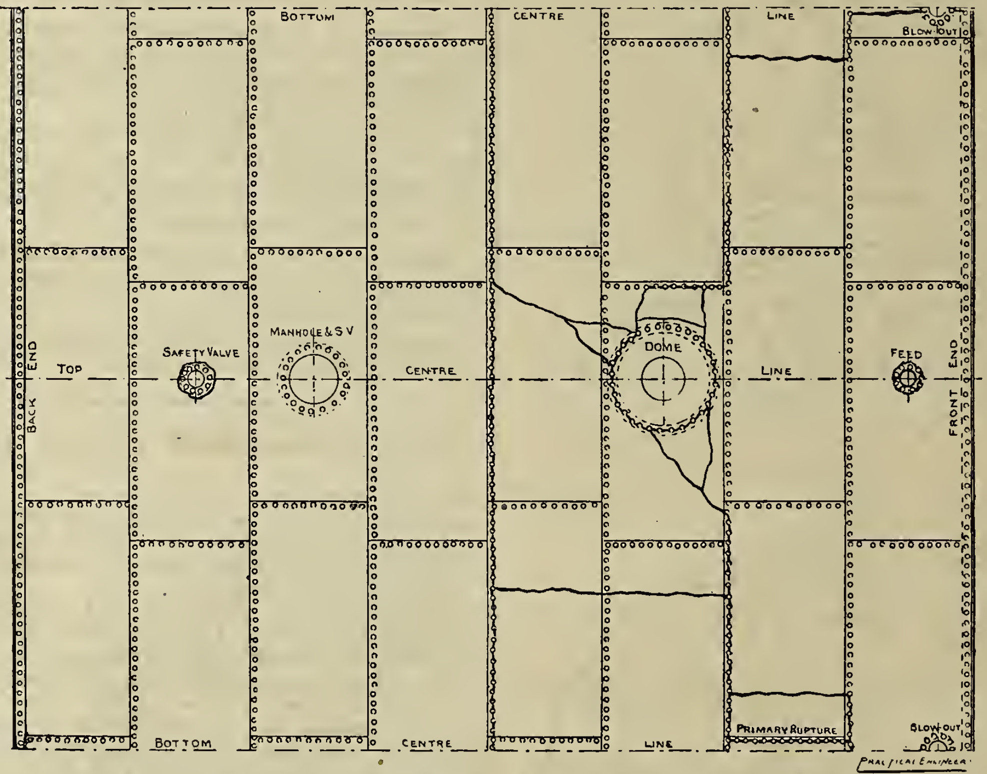


Fig. 2.—DEVELOPMENT OF SHELL PLATES SHOWING COURSE OF RENTS.

boiler. The precise course of the rents will be more readily followed by reference to fig. 2, which gives a development of the shell plates and the line of fractures. The explosion was extremely violent and destructive, and resulted in the destruction of a large portion of Messrs. Watson's premises, as well as in the death of four of the employés, as already stated.

With regard to the cause of the explosion, it may be stated that there were no indications of the ordinary working pressure of 60lb. on the inch having been in any way exceeded, while the fact that the furnace tubes having remained intact negatived the assumption that overheating through shortness of water had anything to do with the disaster. The plates, further, were not wasted by corrosion, so that the explosion was not due to defective condition in the ordinary meaning of the word. At the longitudinal seam, however, at the bottom of the second belt of plating, where we have stated the primary rupture occurred, it was apparent, on inspection, that the inner overlap had been fractured between the rivet holes for a considerable time. The fracture extended from rivet hole to rivet hole, along the line of rupture for nearly the entire width of the belt, with the exception of two or three rivets at each end, and in several places had penetrated nearly through the entire thickness of the plate. As the fracture started from the centre of the joint, however, it was entirely hidden from view, and its existence was not revealed and not suspected until the explosion occurred; so that neither the owners of the boiler, nor those responsible for its inspection, can in any way be held accountable for the explosion. Had there been leakage at the seam in question, suspicion of something being wrong might probably have been excited, but from an examination of the plates there were no signs that the fracture had afforded even this slight evidence of its existence, and it would appear very probable that the crack was originally started when the boiler was being constructed, and that the gradual expansion and contraction, to which all boilers are subject when in work, had slowly but surely developed the flaw until the seam at length became too weak to resist the ordinary working pressure, and the explosion resulted.

This view with regard to the cause of the explosion was supported by Mr. H. J. T. Piercy, C.E., who examined the boiler at the request of the coroner, as will be seen on reference to the following extract from his report. Referring to the cause of the explosion, Mr. Piercy stated as follows:—

> This explosion differs from most of the others I have previously examined, inasmuch as there was no easily apparent cause for it. There was no indication of any of the plates having been heated from shortness of water. On the contrary, the flues were intact, neither of the fusible plugs having been melted. There is also no indication of undue wear and tear, and no signs of leaking. There is also no indication

of over-pressure. The usual working pressure, I understand, was about 60lb., and I found the safety valves were not weighted to blow off at above that amount. On examination of the two front rings of plates to which I have already alluded, it was clear to me that the explosion had commenced underneath them, because they had been not only severed from the rest of the boiler and deposited at the distance of 15ft. away, but the force had opened out the rings nearly flat. It had also torn away a smaller portion, which was not found for several days, and I discovered no satisfactory clue to the cause of the explosion until these missing parts were dug out from among the débris. One of them was found on the third day of my investigation, and two more the day after. I produce these three pieces of plate. An examination of them shows that in a longitudinal seam about 3ft. long there are evident indications of the plate having been partially severed along the line of rivets for probably a very long time. The fact that this partial fracture was most of it hidden between two plates accounted for it not being observed when the boiler was periodically cleaned and examined. The fracture appears to have come through to the inside of the boiler, in one or two places along the seam just between the rivets, but these would no doubt be very fine, and the operation of cleaning out the boiler by brushing the dirt away would so fill them up that it is easily understood why they were not discerned. There is no doubt, as I have before said, that this fracture has existed for a long time, and was, in my opinion, originally caused (or started) when the boiler was being made, probably in punching the holes to receive the rivets, or by the violent process of drifting the holes in order to make them come opposite each other. It is quite possible for a boiler to be put together, completed, and tested by hydraulic pressure without such a flaw being seen. The constant expansion and contraction of the plates during work would tend to disturb and increase the fracture, and to make it liable to give way at any time. As I have been unable to find any trace of there having been any leakage at the fractured seam, I am compelled to assume that no indication could have been observed of the existence of it either inside or outside the boiler. It is clear that when the repairs to which I have alluded were executed the fracture was not visible, because, although the boiler-makers were at work on the very next plate, they did not observe anything that led them to suppose any flaw existed so near to them. There is no doubt a large number of the accidents which have happened have originated in the boiler-maker's hand, and it is satisfactory to find that boiler-makers generally are becoming more and more alive to the extreme caution that is absolutely needful in the treatment of plates in the process of the manufacture of steam boilers.

After this evidence, the jury returned a verdict of accidental death, adding that they considered the owners of the boiler had exercised every precaution in their power to prevent the disaster.

There are several features in connection with the explosion which call for comment, but press of space prevents our dealing with the matter at present, and we must therefore reserve our remarks until our next issue.

(To be continued.)

INFLUENCE OF FLANGED SEAMS ON THE STRENGTH OF FURNACE TUBES.—III.

(Continued from page 502.)

The constants in the board's formula for computing the safe working pressure for furnace tubes made up of one or more short flanged rings is found by the formula—

$$\frac{D \times P}{T \times F} = C \quad (2)$$

where C is the constant, F the factor of safety (5·2), D, P, and T and the diameter, collapsing pressure, and thickness respectively, as defined in formula (1), and it was by this formula that the constants given in Table No. 8 for the several rings composing the experimental tube were computed:—

Table No. 8.

Distinguishing Letter on Ring.	Constants found by Formula (2).
A	12,857
B	11,881
C	12,710
D	12,852

The safe working pressure for furnace tubes made up of one or more short flanged rings is found by the formula—

$$\frac{C \times T}{D} = W\,P \quad (3)$$

where W P is the working pressure in lbs., and C, D, and T have the same signification as in formula (1). The working pressure for each ring in the experimental tube has been computed by this formula, and is given in Table No. 9:—

Table No. 9.

Distinguishing Letter on Ring.	Working Pressure found by Formula (3.)
	Lbs.
A	161·5
B	146·1
C	161·5
D	160·5

It will be seen from this report that the tube first collapsed at ring B with a pressure of 760lb. per square inch, and that after the collapsed part had been supported internally by a stiff cast-iron hoop, it again collapsed at ring D, with a pressure of 835lb. per square inch. It is probable that ring D was not materially strengthened by the cast-iron hoop placed within ring B, but this cannot be said of rings A and C; and therefore the results of testing those two sections are not of much value, beyond proving what very short tubes will do when their ends are securely fastened to rigid bodies. The resistance of the tube, even at the weakest part, was undoubtedly great for a tube of this description and quality, but the explanation of this appears to lie in the fact that all the rings were of excellent form. It is, however, impossible to say definitely whether ring B was or was not stiffened by the external hoop which encircled it. I am disposed to believe that it had little influence, if any, on the collapsing pressure of the tube; but the fitting of this adjunct is to be regretted, as its presence cannot but leave a doubt where all should have been certainty.

Fig. 1. (Plate II)

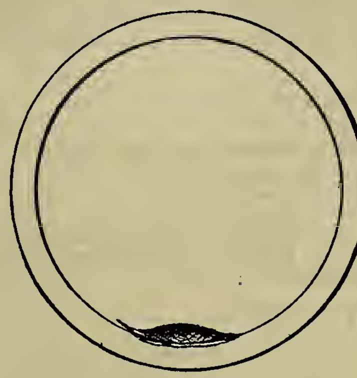


Fig. 2

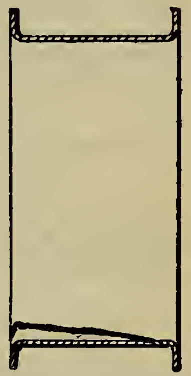


Fig. 3.

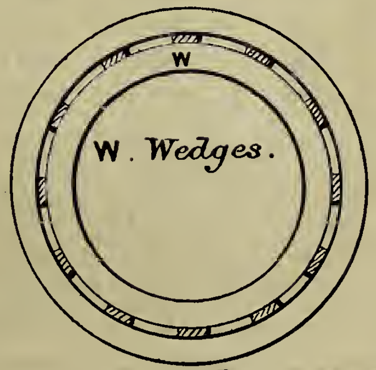
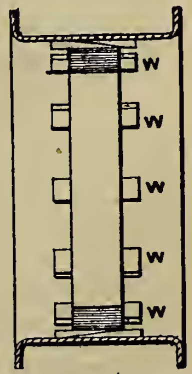


Fig. 4.



PracticalEngineer

This experiment is doubtless very instructive, useful, and interesting; but furnaces of this description are now seldom used for marine boilers, owing to leakage having frequently been found to occur at the numerous circumferential seams, and to the plates occasionally cracking at the roots of the flanges. Mild steel is well adapted for flanging purposes, and is much superior in this respect to iron, unless the latter be of a very high quality; yet it is obvious, from the serious rupture of the experimental tube at the root of one of the flanges, as well as from the appearance of the metal at the fracture, that flanged tubes, even when made of that material, are not so reliable, or as free from the danger of ripping after collapse has occurred, as tubes in which flanging is reduced to a minimum.

From the results of this and other experiments that I have witnessed, it is evident that the collapsing resistance of tubes, composed of short-flanged rings of similar dimensions, except as regards length, increases somewhat as the length of the rings is reduced. This feature in these tubes is only what might be expected, for the shorter the rings, the greater must be their resistance to change of form; and, in addition to this, the available section of metal to resist pressure is augmented by the increased number of flanges, &c., which very short rings necessitate.

The data necessary to frame a rule that would give full effect to the change referred to is not as complete as might be desired, but the following formula fairly meets such cases as the one under consideration, and may be found useful when the rings are much shorter in proportion to their thickness than those composing ths experimental tube:—

$$\frac{\left\{ 13830 - (5030 \frac{l}{L}) \right\} T}{D} = WP \quad (4)$$

where D = outside diameter of the ring in inches;
l = length of ring between flanges in inches;
L = maximum length of ring in inches for which the formula is applicable, viz. (135 × thickness of ring in inches) − 12
WP = working pressure in lbs.;
T = thickness of the ring in inches.

As there are still engineers holding prominent and responsible positions who profess to believe in the reliability of Sir William Fairbairn's formula for estimating the cold-water pressure at which short cylindrical *iron* tubes might be expected to collapse, it will be well in conclusion to compare the collapsing pressures so found with those obtained from this set of experiments.

Fairbairn's formula is:—

$$\frac{806300 \times T^2}{L \times D} = P \quad (5)$$

where D = diameter of the tube in inches;
L = length of the tube in feet;
P = collapsing pressure in lbs.;
T = thickness of tube in inches;

and the collapsing pressures of the several rings of the experimental tube as found by it are given in Table No. 10, together with the actual collapsing pressures for comparison:—

TABLE No. 10.

Distinguishing Letter on Ring.	Collapsing Pressure as found by Experiment.	Collapsing Pressure as found by Fairbairn's Formula.	Collapsing Pressure as found by Fairbairn's Formula greater than actual Collapsing Pressure.	Ratio of calculated to actual Collapsing Pressure.
	Lbs.	Lbs.	Lbs.	
A	840	2,857	2,017	3·40 to 1
B	760	2,730	1,970	3·59 to 1
C	840	2,917	2,077	3·47 to 1
D	835	2,809	1,974	3·36 to 1

These results are conclusive, and consequently render comment unnecessary, but it may be remarked in passing that the actual collapsing pressures would have been less, and the contrast between the actual and calculated pressures greater, if the tube had been iron instead of steel, the latter metal being more homogeneous and stiffer than the former. This comparison should have the effect of showing those who still adhere to Fairbairn's formula the danger there is in using it for estimating the resistance of short tubes, but in justice to Fairbairn it should be mentioned that he never intended his formula to be so used, or rather misused.

I have further to add that the tests to which I have referred were witnessed by Mr. Herriot, the Board's Senior Surveyor in Glasgow, by Mr. Mollison, whose name has been already mentioned, and by Mr. Parker, C.E., Chief Engineer Surveyor to Lloyd's Registry.—I am, &c.,

The Engineer Surveyor in Chief, PETER SAMSON.
Board of Trade.

Mr. Howden wished to use furnaces constructed as the one experimented on for pressures higher than that obtained by the rules for ordinary furnaces. Although this description of furnace is not new, such short lengths are not common; hence arrangements were made to ascertain their value by experiments, the results of which are more useful than theory. The board's regulations as to furnaces are in accordance with experiments made by the board's officers on full-size furnaces, not small tubes, and this additional information is a valuable contribution to facts previously ascertained. The experiments have been carefully made, and the report gives the results clearly and in Mr. Samson's usual careful manner.

The Assistant Secretary, Marine THOMAS W. TRAILL.
Department, Board of Trade.

The results of the experiments are extremely interesting, and there are several points to which we wish to direct attention. Pressure of space, however, compels us to hold over our remarks till our next issue.

(To be continued.)

MATERIALS OF ENGINEERING.—VI.

WROUGHT IRON.

THE best iron is used in boiler plates and for rivets. So much depends on the quality of materials in boilers, that specifications for these are stringent. As some sections of boilers are subjected to more destructive influences than others, the qualities of plate are selected accordingly. Ship or bridge plates are not, or should never be, used for any portion of a steam boiler. Best best, or treble best is properly used for shells, and Lowmoor or Bowling, or other brand of best Yorkshire iron, for fire boxes. "Best Yorkshire iron," we may observe, is not the same as "B," but means the highest quality made, and this is the specialty of some half-dozen houses. Staffordshire and Shropshire iron is considered only inferior to Yorkshire iron, but is manufactured in several grades. Though the commoner of these irons sometimes show an ultimate tensile strength as high as those of superior quality, yet for boilers such strength is of little account, because it is not combined with a high percentage of ductility or toughness. Like cast iron which has been re-melted several times, its strength is accompanied by brittleness.

It follows of necessity from the rolling of a material so fibrous as wrought iron, that it is stronger in the direction in which it is rolled than in the direction transverse thereto. It is necessary to bear this in mind in structures such as steam boilers, and to arrange the plates so that the stronger grain shall be arranged in the direction of greatest stress, that is circumferentially. The direction of grain can seldom be detected by mere inspection. When ordering plates it is understood, unless stated to the contrary, that the *first* dimension given coincides with the longitudinal direction of the fibre. When strips are cut off for testing, the difference in direction of the grain is at once apparent, both in respect of tensile strength and in the degrees of angle at which they can be bent, as will be seen immediately.

With wrought iron of good average quality the ultimate tensile strength ranges from 20 to 22 tons, and the limit of elastic strength is about 10 tons. The ultimate strength across the grain is from 10 to 20 per cent less than with the grain. Samples of Bowling and Lowmoor iron have given a tensile strength of 27 tons per square inch, and an elongation of 38 per cent before fracture on a test piece 2in. long. Best Staffordshire iron will give 24 tons tensile strength, and an elongation of 30 per cent in a test piece 2in. long. For best best plates the Admiralty require a tensile strength of 22 tons per square inch with the grain, and 18 tons across the grain; for B plates 20 tons with the grain, and 17 tons across the grain. The Board of Trade limit the *working stress* of wrought iron to 5 tons per square inch.

The commercial tests, like those of the workshop, are largely bending, and these afford excellent indication of the quality of the material, both for strength and ductility. Strips are bent over an edge of small radius, not less than $\frac{1}{2}$in., because the smaller the radius the more severe the test. The bending is usually commenced in a vee block, on whose points the strip is laid, while the central portion is knocked down with a fullering tool. The bending is then completed under the sledge or the steam hammer. This is termed the forge test. The Admiralty require that first-class BB plates of 1in. thick and under shall bend *hot*, without fracture, to 125 deg. lengthways and 90 deg. crossways of the grain. They should bend *cold*, without fracture, as follows: $\frac{3}{16}$in. and under in thickness, to 90 deg. with, and 40 deg. across the grain; $\frac{1}{4}$in. and $\frac{5}{16}$in., to 70 deg. and 30 deg.; $\frac{3}{8}$in. and $\frac{7}{16}$in., to 50 deg. and 20 deg.; $\frac{1}{2}$in., $\frac{9}{16}$in., and $\frac{5}{8}$in., to 35 deg. and 15 deg.; $\frac{11}{16}$in. and $\frac{3}{4}$in., to 25 deg. and 10 deg.; $\frac{13}{16}$in. and $\frac{7}{8}$in., to 20 deg. and 5 deg.; $\frac{15}{16}$in. and 1in., to 15 deg. and 5 deg. B quality iron should bend *hot*, without fracture, in all plates of 1in. and under, to 90 deg. with the grain and 60 deg. across; when *cold*, B plates should bend as follows: $\frac{3}{16}$in. and under, 75 deg. with the grain and 30 deg. across the grain; $\frac{1}{4}$in. and $\frac{5}{16}$in., to 55 deg. and 20 deg.; $\frac{3}{8}$in. and $\frac{7}{16}$in., to 45 deg. and 15 deg.; $\frac{1}{2}$in., $\frac{9}{16}$in., and $\frac{5}{8}$in., to 30 deg. and 10 deg.; $\frac{11}{16}$in. and $\frac{3}{4}$in., to 20 deg. and 5 deg.; $\frac{13}{16}$in. and $\frac{7}{8}$in., to 15 deg.; and $\frac{15}{16}$in. and 1in., to 10 deg.; the last two not bending transversely.

The operation of flanging is one that severely tests the quality of a plate. Inferior iron will not flange, but will crack badly, especially if bent across the grain.

Rough tests for iron, but indicative of general quality, are as follows: Punch holes in a piece of plate as close together as possible, and also close to the edge of the plate, and note if the metal cracks readily between the holes. Punch holes of small diameter, drift them out to one-third or one-half larger, and note the amount of tearing or cracking which results. Nick two pieces from the same plate, and bend one specimen hot, the other cold. If the first breaks badly, it is *hot short;* if the second, it is *cold short.* Note also the character of the fibre, whether truly fibrous and having good metallic lustre, or short, hard, brittle, and of a dull, blackish, dirty colour.

Rivet iron should be of superior quality to plates by two or three tons. Its tensile strength should not be less than 24 tons. This may be taken to represent also its approximate shearing strength, though some estimate the latter at about 80 per cent only of the tensile strength. Rivets should bend cold without fracture until the space between equals the diameter of the iron; if hot, they should bend double. The head should bear flattening out while hot to an eighth of an inch in thickness, or to two and a half times the diameter of the shank, without cracking at the edges. The shank should bear flattening, and stand the punching of a hole while hot without cracking around the hole, the latter to be equal in diameter to the shank. Nick the shank cold, and bend it round to see whether the metal develops a fibrous or a crystalline structure. Bending tests of a very similar character are employed for angle, tee, and channel iron. Angle and tee iron occupies a position about midway between plates and rivet iron, both in respect of tensile strength and percentage elongation.

Temperature is found to affect the strength of wrought iron to a very appreciable extent; hence the bulging and fracture of boiler plates in consequence of overheating. Up to 400 deg. F. the strength remains practically unaffected, but at a red heat there is a loss of nearly 25 per cent of strength. To work iron at a blue heat is found to have an injurious effect upon its quality.

THE ELECTRICAL TRANSMISSION OF POWER.*

WHAT is power, and why should we wish to transmit it? Power has one very definite meaning in science, and several rather vague meanings in practice.

When you walk upstairs you exert power, only, perhaps, the one-twentieth of a horse when you go up slowly, talking to other people. But when you run upstairs, because you have forgotten something that you intended to bring down, then your exertions represent perhaps one-tenth of a horse power. You only get to the top of the stairs in either case, but the breathless sensation of running fast upstairs tells you that the more quickly you go the harder you are working. A person exercises power in the engineer's sense when he exerts himself physically, and the greater the exertion the greater the power. Probably the most familiar example of exerting power at a distance—that is, of transmitting power—is pulling a handle and ringing a bell in another room.

Some houses can still dispense with mechanical or other methods of transmitting power, even to ring bells, but factories cannot. The looms, the lathes, or whatever the machinery used in the factory may be, must either be worked by hand or foot, in the old style, or it must be connected with the steam, gas, or water engine in the new. On entering a large factory, you see lines of rapidly-rotating shafting, and a network of rapidly-revolving belting, all employed in transmitting power. As a contrast to this may be instanced Sir David Salomon's workshop at Tunbridge Wells, in which every machine is worked by a separate electric motor, thus saving to a great extent the loss of power that usually accompanies the mechanical transmission.

But it is not only in transmitting the power from the steam, gas, or water engine of a factory to the various machines working in it that electricity can be utilised. An incredible amount of power is daily running to waste in this and other countries, because many of the rapid streams of water are too far away from towns for their power to have been hitherto utilised. The holiday tourist, when admiring the splashing water dashing over the stones, hardly realises that the money loss is as if the foam were composed of flakes of silver. If we take as a low estimate that a large well-made steam engine burns only two pounds of coal per horse power per hour, the coal consumption which would be equivalent to the waste of power at Niagara would exceed 150 million of tons per annum, which, at only five or six shillings per ton, means some forty million pounds sterling wasted. And descending from big things to small, the river Avon, flowing through Bath, which, so far from being a roaring cataract, especially in dry weather, pursues its course with only a respectable orderly swish, still represents a certain amount of lost power. It has been estimated that from 25 to 130 H.P. runs to waste at the Bathwick weir, behind the Guildhall, depending on the season. If we take, as an all-round average, that the fall of this weir represents 50 H.P., and that a steam engine producing this power burns 150lb. of coal per hour, it follows that with steam coal at 16s. per ton, the price at Bath, the waste at Bathwick weir represents an income of £450 per annum, not a princely fortune, it is true, but too large to be utterly thrown away as at present.

This state of things will, I hope, however, be shortly remedied, since it is proposed to put up 81 electric arc lamps throughout the streets of Bath, and to supply the 50 H.P. required for these lamps by the fall of the Bathwick weir, supplementing the fall with a steam engine at dry seasons.

But, splendid as are the most successful of water powers to actuate distant electro-motors, it is but a stray stream here and there that has yet been utilised, and countless wealth is still being squandered in all the torrents all over the world.

The familiarity of the fact makes it none the less striking that, while we obtain in a laborious way from the depths of the earth the power we employ, we let run to waste every hour of our lives many times as much as we use.

It is also a well-established, time-honoured fact that large steam engines can be worked much more economically than small ones, and that, therefore, if it were possible to economically transmit the power from a few very large steam engines to a great number of small workshops, there would be a great saving of power, as well as a great saving of time from the workmen in these many small workshops, having only to employ this power for various industrial purposes, instead of having to stoke, clean, repair, and generally attend to a great number of small, uneconomical steam engines.

You can all realise the difference between the luxury of merely getting into a train instead of having to engage post-horses, of being able to send a telegram instead of employing a special messenger, or being able to turn on a gas-tap and apply a match when you want a light instead of having to purchase oil and a wick and trim a lamp. Well, a general supply of power to workshops is to the manufacturer what a general supply of light or a general supply of post-office facilities is to the householder. It is all part of the steady advance of civilisation that leads the man of to-day to go to the tailor, the shoemaker, the baker, the butcher, instead of manufacturing his own moccassins and lassoing a buffalo for dinner. And in case any of you may be inclined to think that we have gone far enough in these newfangled notions, and we are all perhaps prone to fall into this mistake as we grow older, let me remind you that while each age regards with justifiable pride the superiority of its ways to those of its ancestors, every generation will appear but semi-civilised to its great grandchildren. Let us accept as an undoubted fact that a general distribution of power would enable the wants of civilised life to be better satisfied, and therefore would greatly benefit industry.

There are four methods of transmitting power to a distance: 1. By a moving rope. 2. By air compressed or rarified at one end of a pipe operating an air motor at the other end. 3. By water forced through a pipe working a water motor. 4. By electricity.

For short distances of a mile or so there is no system of transmitting power in a *straight line* along the open country so cheap to erect and so economical of power as a *rapidly* moving endless rope; but the other systems give much greater facilities for distributing the power along the line of route, are much less noisy, and far surpass wire-rope transmission in economy when the rope must move somewhat slowly, as in tramway traction, or when the distance is considerable over which the power is transmitted, or when the line of route has many bends.

Compressed air is employed to work from a distance the boring machines used in tunnelling; the continuous vacuum brakes used on many of the railways are also probably familiar to you, and the pneumatic system of transmitting power to workshops is shortly to be tried on a fairly large scale at Birmingham.

But distribution of power by water pressure is the plan that has hitherto found most favour in this country. Water pressure has been employed for years on a large scale at Hull for distributing power; also by Mr. Tweddell as a means of communicating a very large amount of power through a flexible tube to tools that have to be moved about; but the grandest illustration of this principle is the vast system of high-pressure mains that has been laid throughout London. The economy of this system is so marked, and the success that has attended its use so great, that did I not feel sure that electricity offers a grander system still, it would be with fear and trembling that I should approach the subject of this evening, the "Electric Transmission of Power." *Punch* drew, six years ago, the giant Steam and the giant Coal looking aghast at the sucking babe Electricity in its cradle. That babe is a strong boy now; let the giant Water look to its laurels ere that boy becomes a man. For the electric transmission of power, even now, bids fair to surpass all other methods in (1) economy in consumption of fuel; (2) more perfect control over each individual machine; (3) ability to bring the tool to the work, instead of the work to the tool; (4) in greater cleanliness—no small benefit in this dirty, smoky age; (5) and lastly, there is still one more advantage possessed by this electric method of transmitting power that no other method can lay claim to—the power which during the daytime may be mainly used for driving machinery, can, in the easiest possible way, be used during the night for giving light.

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* Abstract of lecture delivered by Prof. W. E. Ayrton, F.R.S., before the British Association, Bath meeting, 1888.

It might be said that the transmission of power by coal gas, which I have excluded from my list, fulfils the condition, but so also does the transmission of power by a loaded coal waggon. In both these cases, however, it is the fuel itself that is transmitted, and not the power obtained by burning the fuel at a distant place. In all the last three of the systems on my list some form of power, such as flowing water or the potential energy stored up in coal, wood, zinc, or other fuel, has initially to be utilised; this power is given to some form of air, water, or electric pump, which transfers the power to the air, water, or electricity, by which it is conveyed to the other end of the system. There it is reconverted into useful mechanical power by means of an air, water, or electro motor.

You will observe that I class together air, water, and electricity; but that I do not mean to imply that electricity is a fluid, although in many respects it acts like a fluid, like a fluid of very little mass, however, or, odd as it may seem, like a fluid moving extremely slow, for electricity goes round sharp corners with perfect ease and without any of the phenomena of momentum possessed by rushing water. But what I particularly wish to impress on you by classing air, water, and electricity together is that electricity is not, as some people seem to think, a something that can be burnt or in some way used up, and so work got out of it. Electricity is no more a source of power than a bellwire is; electricity is a marvellously convenient agent for conveying a push or a pull to a great distance, but it is not by the using up of the electricity that electric lights burn or that electro-motors revolve. It is by the electricity losing pressure (exactly as water loses head when turning the miller's wheel as it flows down hill) that work is done electrically.

In each of the four stages—(1) transference of power to the working substance, (2) conveyance of power to the distant place, (3) transference ofpower from the working substance to the motor at the distant place, (4) bringing back the working substance—there is loss of power, and the efficiency of the arrangement depends on the amount of these four losses. The losses may be shortly called (1) loss at generator, (2 and 4) loss on the road, (3) loss at the motor.

(To be continued.)

CORRESPONDENCE.

We do not hold ourselves responsible for the opinions of our Correspondents.

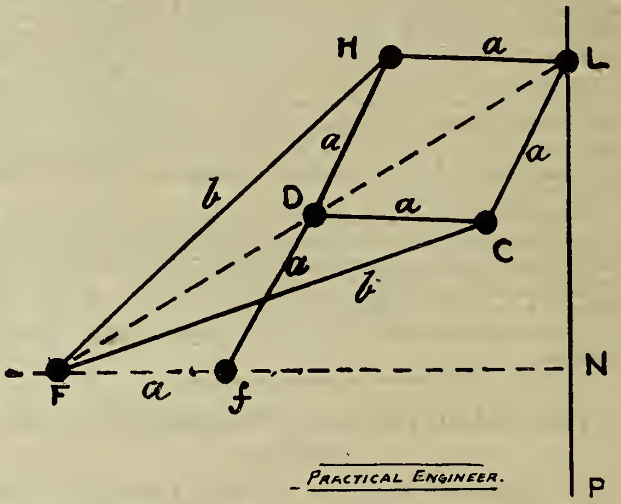
POUCELLIER'S TRUE STRAIGHT LINE MOTION.

To the Editor of "The Practical Engineer."

SIR,—In your issue for September 21st, page 455, the following problem is proposed for solution: "Arrange the dimensions of an instrument for giving a straight line path of twelve inches." One might naturally think that with the many so-called parallel motions which we have, the problem might be solved in a many ways; such, however, is not the case. Although we have the parallel motion patented and used by Watt, as well as the modification of it applied to the side-lever marine engine, and also the so-called Scott Russell's parallel motion, but which the writer knows to have been in use for such purpose much before Scott Russell's time, we have also the late Richard Roberts's parallel motion, as well as the two levers connected by a link which carries the path tracer, as in the Richard's indicator. Now, what seems most remarkable about the above is that no one of them will give motion to a point along a perfectly straight line. They are only approximately parallel motions, their deviation becoming the greater as their extent of traverse is increased, but not absolutely correct, however small the traverse may be. Scott Russell's so-called parallel motion, illustrated in your issue of October 12th, page 490, is really only a copy of a line already supposed to exist, and therefore, from a strictly geometrical point of view, cannot be regarded as a solution of the question at all.

In addition to the above, we have the hypocycloid motion, which is theoretically perfect; but the cogs required in practice on the generating and base wheels destroy that smooth movement required to produce a straight line. A combination of links, as shown in the accompanying sketch, was devised about twenty years ago by Poucellier, a French engineer officer, which produces a perfectly straight lined motion, though engineers and mechanicians in this country do not appear to be well acquainted with it. Probably, if the device were more generally known in this country, it might have many useful applications.

Referring to the sketch, the two links HF and CF are each of the same length (b), and have each one end pivoted on the fixed stud F, and the other ends connected to the two opposite angles H and C of the parallelogram HLCD, whose sides are each of the same length (a); the joint D of the parallelogram is connected to the fixed stud f by the link fD, whose length is also (a), while the two studs F and f are (a) distance apart.



If, now, the joint L be moved, it will be constrained to go along the straight line LNP, which is at right angles to the line through Ff produced to N, and by proper arrangement of the rods the joint L may pass along the line LNP on each side of the line FfN.

That the line LNP is at right angles to the line Ff produced, and also a straight line, may be demonstrated as follows:—

Let the angle DFf = θ. Then FD = 2 as cos θ.

By trigonometry, cos angle HDL $= \dfrac{b^2 - (\mathrm{FD})^2 - (\mathrm{DH})^2}{2\mathrm{DH} \times \mathrm{FD}} = \dfrac{b^2 - (2a\cos\theta)^2 - a^2}{2a \times 2a\cos\theta}$

and $2a\cos \mathrm{HDL} = \mathrm{DL} = 2a\left(\dfrac{b^2 - (2a\cos\theta)^2 - a^2}{2a \times 2a\cos\theta}\right) = \dfrac{b^2 - 4a^2\cos^2\theta - a^2}{2a\cos\theta}$

and $\mathrm{FL} = \mathrm{FD} + \mathrm{DL} = 2a\cos\theta + \dfrac{b^2 - 4a^2\cos^2\theta - a^2}{2a\cos\theta}$

and $\mathrm{FL}\cos\theta = \mathrm{FN} = 2a\cos^2\theta + \dfrac{b^2 - 4a^2\cos^2\theta - a^2}{2a} = 2a\cos^2\theta + \dfrac{b_2}{2a} - 2a\cos^2\theta - \dfrac{a^2}{2a}$

Therefore $\mathrm{FN} = \dfrac{b_2 - a^2}{2a}$ = a constant whatever the angle LFN may be; so a perpendicular from L, whatever position L may have, let fall upon the line Ff produced will pass through the same point N, whose distance from F $= \dfrac{b^2 - a^2}{2a}$. Consequently the path of N must be a straight line, and at right angles to the line Ff produced. In conclusion, if a = 3in., then b = 7½in., and LP may be more than 12in.—Yours truly,

W. A.

Manchester, Oct. 8.

IMPROVED FUSIBLE PLUGS FOR STEAM BOILERS.

To the Editor of "The Practical Engineer."

SIR,—With reference to the article on the "double-cone" fusible plug, which appeared in your issue of the 14th ult., the writer is mistaken in supposing that the "double-cone" is the *only* type of plug that does not permit of *partial fusion*, and that the "screw-cone" type arrangement shown in fig. 1 of same issue facilitates renewal of the fusible part, while, further, the importance of the protector flange is considerably exaggerated. The recently patented "loose alloy ring, with loose gun-metal centre ring disc" plug (Williams's), does not permit of *partial* fusion. On the contrary, with *it* such result is *impossible*—that is, in the sense commonly understood. In this type of plug the immediate result of overheating is that the alloy ring is softened and sheared, the centre disc liberated, and a sufficiently large orifice made for the instantaneous escape of as much steam as will extinguish the strongest fire that can possibly exist in the largest boiler furnace. The supposed facility given for the renewal of the fusible metal in the "screw-cone" arrangement may appear feasible enough in theory, but practice proves that the renewal is not *easily* effected. The difficulty experienced with this arrangement is that the screws frequently get jammed in consequence of the heat to which they are immediately exposed; and a further disadvantage arises from the fact that the attendant is compelled to be on his back when renewing the plug, which, to say the least, is inconvenient. In the loose ring type of plug these difficulties are avoided, as the attachment screw is not exposed to the furnace gases, and a tight joint is secured "without cement or packing of any kind," and effected from the inner side of the boiler when this is possible—an arrangement which is not only the most convenient, but the most desirable, as it prevents concealment of a case of overheating, and secures an opportunity for a more complete examination of the furnace plates. The "protector flange," so frequently referred to in connection with this "double-cone" plug, is, I will venture to state, an unnecessary appendage, the utility of which exists mainly in imagination.

FAIR PLAY.

October 16th, 1888.

STRENGTH OF FURNACE FLUES.

To the Editor of "The Practical Engineer."

SIR,—You have been appreciative enough to publish my letter on this subject in a recent issue. Allow me to correct a clerical error in that letter, in which the correct coefficient in the expression (5) is, as a round number, 29,000; and the consequent coefficient in equation (6) is, as a round number, 205,000, say 200,000, to allow a slight margin. The equation, therefore, correctly stands:

Collapsing pressure of plain iron flue tubes of Cornish and Lancashire steam boilers—

$$p = \frac{200{,}000\ t^2}{d^{1\cdot75}} \quad (6)$$

p = pressure in lbs. per square inch;
t = thickness in inches;
d = diameter in inches.

Yours, &c.,

London, Oct. 17th, 1881. D. K. CLARK.

HOW TO DRAW A STRAIGHT LINE.

To the Editor of "The Practical Engineer."

SIR,—I notice in your paper of the 12th inst., under the heading of "Queries and Replies," a description of the problem of "how to draw a straight line." My object in writing is merely to say that the solution offered in fig. 2 of the reply, for producing motion in a straight line, is that adopted in the construction of my patent steam pumps, in which the connecting rod is the same length as the crank, while the stroke of the piston is four times the length of the crank.—Yours, &c.,

London, Oct. 16th, 1888. JOS. BERNAYS.

[Pressure of space compels us to hold over several letters to our next issue.]

QUERIES AND REPLIES.

FIRING OF MILL CHIMNEY.—A mill chimney, 125ft. high, situated behind three Lancashire boilers and a Green's economiser, "fired" like an ordinary house chimney, after boiler fires were drawn out, dampers shut down close, and the works closed. Do any of your readers know of a similar instance, and can they assist me in preventing a repetition?—L.

Answer.—I may say in answer to querist "L." that we had a similar case at our mill, where the main chimney of four Lancashire boilors took fire internally, and blazed out at the top for a considerable time. On investigation, we discovered the cause was due to an accumulation of gas in the flue between the economisers and chimney, which took fire, ignited the soot, and exhausted its force up the shaft when the dampers were opened, after being closed overnight. Had the gas been confined in the economisers between closed dampers, we might have had a most serious accident. We are all aware such explosions are far from being rare. I know an instance where the fire doors were blown open, and the fire scattered about the stokehole. Is it not a mistake to construct flue dampers which can be tightly closed? If a reasonable leakage space was provided through the upper portion of dampers, gas explosion in the flues would be a rarity.—MILL MANAGER.

A VARYING COAL CONSUMPTION: POLLITT V. LANCASHIRE BOILERS.—We have three of Pollitt's Lancashire boilers, each 7ft. × 30ft., lying alongside a new ordinary Lancashire boiler, 7ft. 6in. × 28ft. One week we fire the three Pollitt's boilers, and the next week two of the Pollitt's with the new Lancashire boiler, having one thus laid off each week. When using the three old boilers our consumption per week is thirty-five tons of coal, but when using two old boilers coupled with the larger new boiler, we burn forty tons per week for exactly the same work and hours. Boiler shells are all covered in alike, and steam pipes coated. The new boiler is noarest the chimney and has the best draught; but why should we burn five tons per week more for the same quantity of steam raised when using it?—CHIEF STOKER.

Answer.—To answer this query properly would require a moderately long essay, and I am not sure whether you would be able to find space to print it. In my experience it is a very common occurrence for new boilers to be more wasteful in fuel than old ones. This, to my mind, is due to the fact that in the *best modern practice* the gases are got away from the boiler too easily and quickly before the available amount of heat has been absorbed from them, and also to the fact that the heating surfaces of modern Lancashire boilers are too smooth, presenting nothing for friction or impinging of the gases, which, along with time, are necessary for abstracting the heat. In short, the heat is sent direct up the chimney instead of being utilised in the boiler. A case has recently come under my notice where a Pollitt boiler, 33ft. long by 7½ft. diameter, has been replaced by an 8ft. boiler with three flues, with the result that the coal consumption has been increased ten tons per week for the same work.—H. W. R.

Answer.—"Chief Stoker" has probably more draught than is requisite for combustion in his new boiler, being nearest the chimney. I have experienced the same difficulty, and have tried "throttling" the draught on the boiler nearest the chimney with success.—L.

ANTI-INCRUSTATION COMPOSITION.—Referring to the letter by "B. J. T." in your last issue, I should be glad if he would kindly inform me where the composition in question may be obtained.—J. L. Y.

SPECIFIC GRAVITY OF SEA WATER.—I should feel much indebted for assistance from you or any of your numerous readers with the following question: A vessel, consisting of a pipe closed water-tight at each end by pistons, which slide inside the pipe, thereby increasing or diminishing the total volume, floats $\frac{9}{10}$ vol. submerged in sea water, when expanded to its greatest extent. By the addition of a certain quantity of sea water the vessel is sunk just under the surface of the water. By means of the pistons its volume is now diminished, causing it to sink. Required, the proportion of this diminution to the total original volume per 100 fathoms sink? Also, How does the specific gravity of sea water vary on an average with the depth from the surface, and between what limits?—JANEY.

PLUMBAGO CRUCIBLES.—I should be obliged if some correspondent would kindly inform me what is the composition which is used in the manufacture of black lead or plumbago crucibles.

DIAGRAM OF STRESS FOR GIRDER.—I should be obliged for any information regarding the most correct method of setting out a parabola for a uniformly-loaded straight girder, supported at both ends, showing line of stress and how to fix length of plate by same. One method I know is to draw the flange plates full size vertically, and make the central vertical line equal to the height thus obtained. But is there not another method of setting up the centre vertical line by taking the areas of the plates and angle irons consecutively?—GYRTONA.

HELICAL WHEELS.—Can any of my fellow-readers inform me of the best mode of setting out the teeth of a pair of bevel helical wheels, the larger wheel to be 34·8in. diameter, with 6in. face and 73 teeth, 1½in. pitch, and the smaller one or pinion 18·14in. diameter, with 6in. face and 38 teeth 1½in. pitch? Also a plain spur wheel 77·98in. diameter, with 140 teeth, 1¾in. pitch, to work in a pinion 40·1in. diameter, with 72 teeth. Any information with regard to making the patterns would oblige.—J. W. J.

Would some reader kindly inform me what is the proportionate strength of helical wheels in comparison with spur wheels having similar diameter, pitch, and face; also what is the rule for finding the breaking strength of helical wheels?—W. R. E.

WEIGHING MACHINES.—Is there any book published dealing specially with the construction of these machines, and what is the price?—T. D.

CHILLED FURNACE BARS.—Can any of your readers give me any information with regard to chilled furnace bars? To what depth can they be chilled from the top surface? Is it difficult to cast chilled bars any length—say 6ft.? What difference does it make in the nature, temperature of fusion, and also cost as compared with ordinary furnace bars?—DURABILITY.

OLIVE OILS.—I should be pleased if any of your readers would furnish me with an easy method for testing the purity of olive oils.—M. BARKER.

HOPPERS FOR GRINDING MILLS.—Having a number of hoppers to make for a grinding mill, I shall be obliged if some reader would give me a rule other than rule of thumb for finding the proper bevil to plane the corners to.—A COUNTRY MILLWRIGHT.

HYDRAULIC RAM.—Can any reader oblige me with a sketch and rules for proportioning a modern hydraulic ram, such, for instance, as the "Galiban" ram? I have studied the description of the hydraulic ram given in Rankine's "Prime Movers," but the sketch there given is very obscure, and I cannot follow the action of the waste water valve.—QUERIST.

TO CORRESPONDENTS.

ATHOS.—We cannot say what royalty you ought to charge. It would depend very much on what advantages the adoption of your device would confer on locomotive owners. Get as much as you can, but take the best you can get. Your first duty to yourself is to get your device patented. You have not furnished your name and address, and we strongly object to dealing with anonymous correspondents.

J. P. W.—The readiest way of extracting the fourth or fifth root of a number is by the use of logarithms. One-fourth or one-fifth the logarithm of the number will give the logarithm of the root required. If you don't understand logarithms, get some friend to explain. An hour's lesson should make you quite familiar with the subject.

MACHINIST.—Messrs. Tangye's catalogue of parts of steam engines to which you refer is published at a price of 2s. 6d., and you could doubtless get a copy by applying to them direct. The prices of the articles are not stated, however, in the list; Messrs. Tangye stating in the catalogue that quotations are only given on receipt of data showing that a *bona fide* requirement is being dealt with.

H. RODD.—We are not aware of the existence of any work treating on water analysis in the way you mention. We rather fear that crude tests of water would run great risks of being unreliable, and mention this to put you on your guard.

CONTINUOUS BRAKES.—The half-yearly return, issued in the form of a bluebook by the Board of Trade, shows that on June 30 last 51 per cent—an advance of 3·5 per cent since the last return—of engines and tenders used by the railways of the United Kingdom were fitted with continuous brakes, while the proportion of carriages so fitted was 76 per cent, an advance of 5 per cent. It appears that the number of miles run by trains fitted with these brakes is 66,053,727, which means 89 per cent of the whole passages performed. The brakes chiefly used are the automatic vacuum and the Westinghouse automatic.

MISCELLANEA.

Reported Discovery of Petroleum in Cheshire.—At a meeting of the Northwich (Cheshire) Rural Sanitary Authority on Friday last, the surveyor reported that a well at Anderton, the property of Messrs. Greenall and Co., brewers, Warrington, had ceased to yield water, and had begun to yield petroleum, which burned freely.

Steam Boilers in France.—From a French official return it appears that the total number of steam boilers, engines, &c., now in use throughout France has risen to 42,600 as against 29,600 ten years ago, the increase it is stated being due in a great measure to the fact that there are now 13,000 steam engines of one kind and another employed on French farms, compared to 4,800 ten years ago.

Exhibition of Turnery.—The 20th annual exhibition of turnery, under the auspices of the Turners' Company, will be held at the Mansion House on the 24th inst. and two following days, and the prizes will be presented on the 26th inst., at noon, by the Lord Mayor. The competition this year will be in turning in diamonds, glass, stone, and pottery, and the company's prizes will be supplemented by gifts of the Baroness Burdett-Coutts, Mr. Burdett-Coutts, M.P. (the Master of the company), Sir C. Hutton Gregory, and others.

Adams' Vortex Blast Pipe.—In the description of the new locomotive works of the London and South-Western Railway, which appeared in our issue of the 5th inst., we stated in referring to the economy attending the adoption of the new vortex blast pipe, that the appliance was the invention of Mr. William Adams, the present locomotive superintendent, whereas it is the joint invention of Mr. W. Adams and of his nephew, Professor Henry Adams, of the City of London College.

The Population of India.—The Statistical Abstract of India, which has just been issued, contains an estimate of the present population of India. According to the census of 1881, the population of British territory was 198,790,853, and of the native States 55,191,742, giving a total of 253,982,595. The estimated population of Cashmere (which was not included in the census) in 1873 was 1,500,000, of Upper Burmah in 1886 3,000,000, and of the Burmese Shan States 2,000,000. The yearly increment of the population is at least ½ per cent. With these additions, and with allowance for annual increments since the census of February, 1881, the population of India in March, 1887 would be—British territory 207,754,578, the native States 60,382,466, giving a total population for all India of 268,137,044. Both in British territory and the native States the number of males is much larger than that of females. In 1881 in British territory there were 101·2 males to 97·4 females, and in the native States 28·7 males to 26·4 females, and in all India there were in that year just 6,013,419 more males than females.

The Qualities of a Good Rope.—A good hemp rope is hard, but pliant, yellowish or greenish grey in colour, with a certain silvery or pearly lustre. A dark or blackish colour indicates that the hemp has suffered from fermentation in the process of curing, and brown spots show that the rope was spun while the fibres were damp, and is, consequently, weak and soft in those places. Again, sometimes a rope is made with inferior hemp on the inside, covered with yarns of good material—a fraud, however, which may be detected by dissecting a portion of the rope, or, in practised hands, by its behaviour in use. Other inferior ropes are made from short fibres, or with strands of unequal length or unevenly spun—the rope in the first case appearing woolly, on account of the number of ends of fibre projecting, and, in the latter case, the irregularity of manufacture is evident on inspection by any good judge. This consists in forming balls of loose fibre of the ropes to be tested and burning them completely to ashes. While pure Manilla hemp burns to a dull greyish black ash, Sisal leaves a whitish grey ash, combinations of Manilla and Sisal yielding a mixed ash resembling the beard of a man turning from black to grey.

The Mineral and Iron Trade in France.—The Statistical Commission appointed by the French Minister of Public Works has addressed an interesting report upon the production of coal, iron, and other minerals in France during the last four years. According to this report, the total quantity of coal raised during the year 1887 was 21,450,000 tons, or rather more than the total for 1883, which had up to that time been the best year ever known in France. But although the output of coal last year was greater than it had ever been before, the consumption fell from 32,439,000 tons in 1883 to 29,619,000 tons last year, which is equivalent to saying that the imports were less by about 3,000,000 tons. This decrease is attributed by the commission to the crisis in the iron trade, the annual production of iron and steel, which reached 3,570,000 tons in 1883, having dropped to 2,712,000 tons in 1887. Appended to this report are some tables showing the total output of coal and the manufacture of iron in other countries during the same period, and it is worthy of remark as regards the manufacture of iron that while the totals for 1886 show a decrease in all the European countries, there was an increase of 1,665,000 tons in the United States. It may be added that the report of the commission gives the total output of coal for the whole world at 407,000,000 tons and the manufacture of iron at 20,500,000 tons.

SELECTED PATENTS.

APPLICATIONS FOR LETTERS PATENT.

October 12th.

14657 Grates, J. Davies and T. Walmsley, Manchester.
14663 Siphon Cisterns, J. E. Rogers, Tipton.
14668 Screw Clasp Fastener, E. Jobson, Newcastle-upon-Tyne.
14669 Indicators, E. T. Fisher, Birmingham.
14673 Permanent Way, D. Smith, Shropshire.
14675 Gas, H. D. Fitzpatrick and G. Rose, Glasgow.
14687 Electric Lamp, J. Lowe, H. M. Abbott, and G. Gwilt, London.
14698 Ore Stamps, A. Davy, London.—[Complete Specification.]
14701 Chlorine, H. W. Deacon, and F. Hurter, London.
14702 Ores, J. Nicholas and H. G. Owen, London.
14703 Electric Currents, P. W. Willans, London.

October 13th.

14706 Machine Tools, G. C. Bingham, Bermondsey.
14707 Valves, &c., J. Hibberson, Sheffield.
14713 Screw Presses, S. Coupland, London.
14714 Valves and Valve Gear, A. Ridge, Manchester.
14717 Hubs of Wheels, G. Hookham, Birmingham.
14718 Joints of Pipes, R. B. Pope, Glasgow.—[Complete Specification.]
14722 Propellers, J. F. Humphrey, Liverpool.
14723 Valve Mechanism, J. H. Dickson and H. W. Schwaben, Glasgow.
14736 Lubricator, G. Ainsworth and S. T. Ainsworth, Manchester.
14741 Electricity for the Propulsion of Tramway Cars, T. Pease, Cheshire.
14744 Ball Cocks or Valves, C. Duncan, Glasgow.
14757 Steam Engines, P. Evans, Liverpool.
14759 Pumps, A. R. Murrison, Essex. (J. Christie, S.S. "Altonower," at Sea.)
14762 Balance Wheels, P. Perret, London.—[Complete Specification.]
14770 Steam Engine and Hydraulic Crane Combined, W. Cross, London. [Complete Specification.]
14771 Steel Shell Bodies of Projectiles, R. A. P. Taunton, Birmingham.
14772 Meter, G. F. Redfern, London. (L. Brillié, France.)—[Complete Specification.]
14773 Fastenings for Belts, C. H. Watson, London.

October 15th.

14778 Triple-expansion Engine, G. G. Rhodes, J. S. Critchley, and C. Cole Bradford.
14783 Spindle Bearings, T. Thorp, Whitefield.
14789 Electricity for Driving Tramway Cars, &c., T. Pease, Cheshire.
14794 Metallic Packing, W. G. Nixon, Barnsley.
14795 Propelling and Heating Street Cars, W. E. Prall, Manchester.
14804 Axle Box Guards, R. Hudson, London.—[Complete Specification.]
14807 Coating Metal Plates, E. Brazier and J. Thompson, London.
14808 Rolling Mills, J. K. Bealey and S. Adams, London.
14813 Tool-holder, J. Mortimer, Manchester.
14814 Cartridges, W. Ellicott, London.
14816 Pumps, A. Reis, London.
14817 Furnaces, S. Fox, J. R. Fothergill, and D. B. Morison, London.
14823 Steam Engines, H. H. Westinghouse and F. M. Rites, London.

October 16th.

14831 Gas Engines, H. Williams, Manchester.
14832 Furnaces, G. F. Gallagher, London.—[Complete Specification.]
14833 Copper Amalgamating Plates, A. E. Sarti, London.
14834 Wood Wool or Wood Straw, S. Cooper and T. Cooper, jun., Manchester.
14837 Refining Metallic Ores, H. H. Eames, Manchester.—[Complete Specification.]
14843 Electric Meters, J. Oulton and J. Edmondson, Halifax.
14848 Axles, &c., F. W. Webb, London.
14854 Fire-proofing Compound, B. F. McIntyre, London.—[Complete Specification.]
14855 Anti-friction Bearings, W. E. Elliott and J. R. Lane, London.—[Complete Specification.]
14871 Grinding Rolls, P. F. Dooley, London.—[Complete Specification.]
14872 Gas, J. M. Rose, London.—[Complete Specification.]
14874 Slide Valves, W. P. Thompson, Liverpool.
14880 Heating Feed-water, C. J. Galloway and J. H. Beckwith, London.
14888 Electric Cranes, T. D. Hollick, London.

October 17th.

14892 Locking Nuts, A. T. Tucker, London.
14904 Lubricating Machine Chains, C. P. Byrne and F. Haisman, London.
14910 Electrical Induction Coils, S. A. Lovick, Derby.
14916 Tilt Hammer Helves, D. Smith, Wolverhampton.
14918 Regulating Cock, F. Westmeyer, London.
14924 Incandescent Electric Lamps, E. Böhm, Clerkenwell.
14930 Springs, C. H. Pugh, Middlesex.
14931 Evaporating Water, E. Paul, Liverpool.
14932 Incandescent Lamps, S. W. Maquay, London.
14937 Sheet Metal, E. Norton and J. G. Hodgson, London.—[Complete Specification.]
14939 Consuming Smoke, E. D. Tovee, London.
14944 Compound, E. Edwards, London. (H. E. D, Bourdin, France.)
14946 Valves, I. Beardmore, Glasgow.

October 18th.

14952 Water Gauges, J. Dewrance and G. H. Wall, Lambeth.
14963 Electric Bells, E. Cox-Walker and A. A. C. Swinton, London.
14966 Admission of Steam to Cylinders, P. Harvey and W. Harris, Stockton-on-Tees.
14972 Trip Hammers, A. Hartley, Sheffield.
14973 Self-acting Mules, J. Richmond and J. Benson, London.
14975 Sleepers, W. Firth, London.
14976 Engines, C. Glover, London.
14980 Capstans, &c., R. R. Hutchinson, London.—[Complete Specification.]
14993 Metallic Tubes, J. Shepherd, London.—[Complete Specification.]
14997 Files, W. Lockwood, Liverpool.
14998 Chimney Flues, A. Rost, London.—[Complete Specification.]
15001 Lubricator, G. H. Kendall, Huddersfield.
15010 Taking-off Motion, A. G. Fox and J. E. Ashton, Manchester.
15011 Heating and Ventilating, H. Fischer von Roslerstamm, London.—[Complete Specification.]

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Numerous complaints having been made to us by Subscribers of the difficulty they experience in obtaining copies of the *Practical Engineer* in certain districts, we have to state that the Journal can be obtained by any Newsagent through the ordinary trade channels, and no difficulty should therefore exist in obtaining copies by order of any Newsagent.

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EDITORIAL NOTICES.

All communications for the Editor of this Journal should be addressed to 6, Victoria Station Approach, Manchester.

Communications intended for insertion in the current week's issue should reach us not later than Tuesday Evening.

We cannot undertake to return rejected manuscripts or drawings unless accompanied by a stamped and directed envelope.

Contributors are requested to write on one side only of the paper. Sketches should be sent on separate sheets.

TO ADVERTISERS.

Advertisements intended for insertion in the current issue should reach us on Wednesday morning at the latest.

THE
PRACTICAL ENGINEER.
NOVEMBER 2ND, 1888.

SPECIFICATIONS.

When we consider that the same means of obtaining data are open to all engineers, it seems curious that there are such wide differences of opinion amongst the members of the profession. A few years since, two of our leading railway engineers issued specifications for very similar work; one specified the riveting to be done by hydraulic riveters, the other insisted that the riveting should be done by hand. The hand-riveting specification was probably inspired by a boiler-maker of the old substantial school, while the hydraulic would be preferred by a man simply experienced in girder work. These remarks, however, are preliminary, as the particular matter to which we desire to direct attention in this article is the way in which the elastic resistance of the component members of structures is overlooked so far as their differences are concerned. For instance, there is a girder or engine frame to be made, and we find the elongation of the plates specified to be 10 per cent before fracture, and that of the connecting angle irons 15 per cent.

Assuming, as we reasonably may, that the modulus of elasticity is in ratio to the extension before rupture, we must conclude that any strain upon work constructed according to such a specification as that referred to must tend to cut or "work" the rivets, as the angle irons, extending more than the plates, would not take their proportionate share of the total stress.

The ultimate resistance of materials is not really to be calculated upon for practical purposes so much as the limit of elasticity, for so soon as permanent set accrues the destruction of the work commences, and it is then only a question of time how long it will serve its purpose. If a working stress of four tons per sectional square inch is adopted for wrought iron, the elastic limit should certainly be eight tons to give the necessary margin of safety, and more especially should this be observed in structures liable to sudden "jars," such as cranes for warehouse, wharf, and railway use, and the framework of percussive tools, and the under-frames of locomotive engines and goods wagons. Perhaps the latter class of work is more liable to derangement and fracture than that previously referred to, as from the mode of coupling up goods wagons, they must be started with a jerk, as the locomotive engine has to pick up her load, so to speak, truck by truck.

While dealing with the question of specifications the tests prescribed for railway tires may be mentioned, and more particularly as to their bearing on the good or bad quality of the work delivered, and therefore upon the durability of the wheels supplied. The best makers—that is, those who supply the best material—are placed at a great disadvantage by the differences in specifications, for the makers of inferior work will quote just up to the price of material to stand the stipulated tests, whereas the more genuine manufacturers will quote for work they will guarantee, regardless of lapses in defective and incomplete specifications. At the present time, when the demand for wheels and axles is becoming brisk, some stress should be laid upon this point, for with increasing traffic the necessity of insuring soundness in the tires and axles becomes more apparent, especially in the case of those for foreign railways, where there may be difficulties in the way of renewals and repairs.

There has lately been some discussion as to the propriety of engineers giving chemical specifications for steel, instead of fixing merely upon tests of strength and elasticity, and leaving it to the manufacturers to determine the proportions of the ingredients. In our opinion, the composition of the steel should be left to the makers, who have a practical knowledge of the matter, whereas the civil engineer will probably have to obtain his information at second hand.

Another point to which reference may be made on behalf of the manufacturers is the way in which some civil engineers *allow manufacturers* to send in alternative designs and alternative specifications. Why, we ask, should the engineer, who insists on claiming an autocratic control of the work, endeavour to obtain his information from the people he pretends to direct ?

An amusing incident in this connection occurred recently in reference to indiarubber buffers, where an impossible specification as to composition was given, and an alternative one invited ; in this matter the maker very wisely kept his own counsel, and refused to give away the fruits of his own experience.

We might dilate upon this topic to an unlimited extent, but want of space forbids a further extension of our remarks on the present occasion, and we therefore content ourselves with pointing out the most salient features that we think may interest our readers.

THE SALT SYNDICATE.

The inevitable result which we ventured to predict would follow the attempt on the part of a syndicate to establish a monopoly in the salt trade, to which we referred in our issue of the 12th ult., is making itself manifest sooner even than we expected. We are informed that it is the intention of several capitalists to immediately sink brine shafts, and establish extensive works in Cheshire, in opposition to the action of the syndicate. The large advance in prices which the action of the Salt Union has for the moment produced is leading, as we ventured to say it would, to keen opposition, and as the Salt Union has failed to secure the entire possession of the whole of the salt-bearing lands, rival establishments will be set up at their very doors, the result of course being that a larger amount of capital will be sunk in the industry than existed during the recent period of depressed prices, while the output, which it was contended was too large already, will be further increased. The inevitable sequel to this excessive and unhealthy production, as we have already pointed out, will be a collapse in prices as soon as the inflation caused by the present panic has subsided, followed sooner or later by the collapse of the syndicate, and the sooner the better, say we, for all concerned.

THE THREATENED COAL STRIKE.

The danger which threatened in a greater or lesser degree the whole of the manufacturing industries of the country about a week ago from the impending colossal strike in the great coalfields of the North and Midlands may now happily be regarded as past. The advance of 10 per cent which was demanded by the men has been so generally conceded that there is little risk of the owners who still refuse to make the concessions offering much further resistance. In South Yorkshire, Lancashire, Staffordshire, and North Wales the advance was to a large extent conceded pretty early in the struggle, but in the Nottinghamshire and Derbyshire districts there were some indications that a bitter and prolonged fight was about to be commenced. This, however, has been avoided by the owners conceding the advance asked for. We are glad the dispute has been settled amicably, and without resort to what is little better than social warfare. Strikes are at best but a barbarous and clumsy method of settling wage disputes, while the results obtained are hardly ever commensurate with the misery and loss experienced in the course of their existence, and never attain what would not invariably be brought about by the natural force of circumstances without their aid. The success of the present demand may perhaps by some be regarded as convincing proof of the contrary, but we very much doubt whether an advance in wages quite equal to, if not greater, than that already obtained could have been much longer delayed. The fact is that rates of wages are, as a rule, settled by laws over which neither masters nor men can exercise much influence or control. But "All's well that ends well," and we must confess to experiencing a considerable amount of gratification at having escaped the terrors of a gigantic strike in our leading manufacturing industry just at present, when signs are making themselves manifest that trade has at last begun to experience a general revival. Nothing, to our minds, would be so likely to check such a satisfactory movement and throw the benefit of any advantage attending it into the hands of our foreign rivals as the paralysing influence which would inevitably have attended a general strike amongst colliers, and we are glad for this reason alone that such an extreme measure has been avoided.

GASWORKS MANAGEMENT.

The facts which were brought to light in connection with what was known as the Salford gas scandal, and which our readers will be aware resulted in Mr. Samuel Hunter, the late manager of the Salford Gasworks, being sentenced for a term of penal servitude, has led to a number of other investigations being made with regard to the management of gasworks generally, with results that cannot be regarded as altogether satisfactory. At the time the Salford inquiry was pending a scandal of a somewhat similar nature led to the resignation of the manager of the Wigan Gasworks. This has since been followed by some ugly revelations at Halifax, and we now learn that Mr. Ellis Lever, against whom Mr. S. Hunter in the first instance brought a criminal action for libel—which subsequently constituted the charge of perjury on which Hunter was eventually convicted—has just presented a report to the Town Clerk of Leeds with regard to some investigations he has been making into the quality of the coal supplied under contract to that corporation. The report reveals a condition of things which reflects considerable discredit upon someone. It states that cannel coal has been delivered which was not only below sample, but contained foreign matter as well as coal of far inferior and almost worthless quality. The tests made showed that this adulteration with the cannel reached as high as 20 to 30 per cent, and in some cases even more, the effect being not only to reduce the quantity of the gas made, but also to increase the amount of sulphurous impurities, thus rendering the gas injurious to sight, breathing, and furniture. The report goes on further to state that no efficient system of checking the weights of coals delivered seems to have been in operation. At a meeting held on the 26th ult. a sub-committee was appointed to investigate the charges, and we sincerely trust for the benefit of all concerned that a satisfactory explanation may be forthcoming to account for the discrepancies.

AN ENGINEER'S LIFE AT SEA.—XVII.

BY A SEA-GOING ENGINEER.

(Continued from page 497.)

Work in Port.

In a well-ordered ship the social mechanism moves as quietly as the mechanical, a complex and wonderful organism, but its working unnoticed in proportion to its efficiency. With the regular rotation of watches an engineer also gets into the regular swing of the engines, and seems so to become a part of them that the monotony is not disagreeable. In port, daywork takes the place of the watches at sea, and on the day after arrival this work begins. Usually the main brasses have to be let together, and pumps, valves, and pistons overhauled. Besides this regular work there are always a number of defects which develop on the voyage and have to be attended to. After the most urgent of such defects have been remedied, whatever there is not time to do in one port is left to be done in the next one.

When the work begins the "second" gets the men round him on the platform, and sends them by a word to their pre-arranged tasks. He has to suit the men as far as possible to their work, and soon gets to know their various qualifications. He also tries to have the work done with the least possible bustle, and whenever he can will give a man a job that will last him all day, so as not to "mess the men about." He himself, besides general supervision over all, usually keeps a couple of men beside him to assist in overhauling brasses, valves, or pistons. The first thing is to turn the engines after he has made sure that the propeller is clear. Once a turning gear got stiffer to turn with each stroke. As there was no apparent reason for this, it was reversed, but at the first pull the bar flew across to the bulkhead, the "second" narrowly escaping a broken leg. It was then found that a mooring chain under the water had fouled the propeller. The turning of engines is needed to get the cranks on their centres for stripping brasses, or for overhauling the pistons or pumps. If there be no time to take out the top end brasses, the crosshead is fastened up usually by a steel pin inserted into a hole in the guide, and the rod is swung while the brasses are tightened up. When there is not time to uncouple the bottom brass, its side shake is tried with a handspike, and it is tightened up accordingly. With lead wire, "leads" are occasionally "taken off" a brass, two being put in transversely and one longitudinally. The clearances on the sides of each brass, which in width are about a sixth of the diameter of the pin, are re-filed out if necessary and the gutterways deepened. The rounded edges of the brasses must not bear on the chamfers of the pin, or they will prove a fruitful source of over-heating. The necks also of the crank pins should be examined all round for cracks, as it is here that failure of a pin usually begins. With main bearing brasses occasional lining up is as necessary as letting down the top brass, as this keeps the shaft in line. The front brass is the one which needs this most, as shown by the jump on the overhung end of shaft. The play on the shaft in a fore and aft line must be determined by putting a strain on it "ahead" and "astern." This is best done by marking the shaft while working the ship into port, but if this be omitted, it will be found that the oblique thrust of the worm on the turning wheel will slide the shaft forward or backward the full amount of its play, though wooden wedges may have to be used to assist. If the shaft has worked its way so far forward that the bottom end brass is rubbing hard on the after cheek of the crank, the shaft must be set back. Examination of the brass is not a sure guide, for brightness will frequently be found on the forward as well as the after side of the brass caused by rubbing. In setting back the shaft the steel wedges at the thrust block must be driven further home, and by thus forcing the thrust block aft, the wear of its rings is compensated. Such a process, however, has to be only rarely resorted to. Of course, when there is excessive play of the shaft, due to thinning of the rings, these will have to be renewed, for not only are they weakened directly by their wear, but the play on the shaft puts a blow upon them in reversing the engines, and in this way doubles their weakness.

In turning the engines the "second" should always see for himself that there are no blocks of wood to foul them at the back, and that there are no lashings to resist the movement of the engines; also that bagging is removed from the steam ports on top, and that all is clear. With pump links loose, the "third" should stand at the back while the turning is going on, so as to enter the links on their pins as they come together. The least carelessness may cause something to be overlooked. With the low-pressure piston on the down stroke the turning usually becomes so easy that the lever is sometimes removed and a spanner put on the square. This is a dangerous practice, for sometimes the engine will run away and spin the worm round, and the spanner may thus injure the operator. It is best to remove the bar and work the lever and pawl by hand. These are hints of caution for inexperienced "thirds," who may be set to preside over the turning while the "second" is engaged elsewhere. For the same reasons it is also necessary to keep clear of the engines while they are being turned. If they have to be left standing in an unstable position, reversal of the lever and engagement of the pawl in the ratchet-wheel will hold them securely at rest. In pulling a rope a lazy man will always try to get to the tail end of it. If he has an old hand in front of him, the latter may at one stroke hold the rope still instead of pulling, so as to show what pull the other is putting on it, and expose him, or the hardest-working man will unexpectedly stop so as to let the others see that he is doing all the work.

When links have enough side clearance and deep enough gutter ways, they are best tightened by shaking sideways by hand, liners being taken out or changed till the nuts can be fast locked with the proper amount of shake on. Sometimes a brown paper liner in or out will make the difference in tightness required.

When link or other brasses are removed they should always be carefully marked or examined for marks already on. Though intended to be interchangeable, they get worn to their work, and run best in their usual position. When frothy bubbles are seen working up through the oil hole in a link at sea, it should be noted in port whether that link is the same length as its companion. Should the latter be doing the main part of the work, there may be no appreciable knock, but the spring and looseness of the other will draw air in and out of the air hole and cause these bubbles. If the strains on the links be thus unequal, this will probably be shown by comparison of the rubbing marks on the brasses, thus affording another good reason for never interchanging link brasses, nor turning them end for end, for this confuses the marks of wear.

Eccentric straps, when let together, should be made just tight enough to run round by their own weight. By swinging the eccentric rods the tightness of the top brasses can be also regulated. When overhauling the valve gear, should the quadrant get lower at one end than its working position, and pulley blocks or men not be available at the time, it can be raised single-handed by putting the rod at an angle with a block of wood under its foot while the quadrant is at one end of its travel, and then by running over the quadrant with the turning wheel it will be raised, and can be secured while the foot of the rod is released and swung on to its position on the strap.

When the main slide valves are out their ports should be marked on staves made for the purpose and kept for reference. In setting a valve the corresponding crank is turned to its top centre, and the opening for pre-admission measured by a wooden wedge. The crank is then turned to its bottom centre, and the opening at the bottom end of the valve taken in the same way. Thus the top and bottom openings can be equalised, or more opening can be given on the bottom to counteract the extra momentum due to the weight of the rods; but, as previously noted, the expansion upwards of the engine by heat tends to give this extra pre-admission without the engineer making special provision for it. By drawing horizontal lines from the ports in valve and cylinder to where they can be seen, compression, exhaust, &c., can be traced all the way round for ahead and astern on both valves with any one revolution of the engine.

(To be continued.)

THE NEW ITALIAN IRONCLAD, THE RE UMBERTO.

THE Re Umberto, launched about a week ago at Castellamare in the presence of the Emperor William and King Humbert, is a steel-built, twin-screw, deck-protected, barbette ship of 13,298 tons displacement. She is therefore very little smaller than the Italia, which was launched also at Castellamare in 1880, and the Lepanto, which was launched at Leghorn in 1882. As far as beam alone is concerned, she is bigger than either of those leviathans; and in this respect there is nothing afloat that can rival her.

Her dimensions are—length 400ft. 4in., breadth 76ft. 9in., and her mean draught of water, with all her weights on board, is expected to be 28ft. 8in. She cannot fairly be ranked as an ironclad, seeing that she has absolutely no side armour at the water-line. A large amount of protection is, however, afforded to her by the construction of her bottom and sides, by the subdivision of her hull into a great number of water-tight compartments, and by a curved steel deck in the neighbourhood of the water-line. The ship's bottom is composed of three skins, which form two water-tight spaces that are further subdivided transversely.

Experiments to test this mode of construction were made several years ago in Spezzia harbour. A caisson, built up in a similar way, was moored, and a charge of 75lb. of gun-cotton was exploded in contact with it, and at a suitable depth. The two outer skins were ruptured, but the inner skin remained intact. Subsequently, the inner one of the two spaces was filled with coal, and the experiment was repeated. This time, only the outer skin was shattered. It may, therefore, be taken as proved that the construction of the Re Umberto affords protection against a torpedo charged with not more than 75lb. of gun-cotton.

The armoured deck leaves the ship's side 6ft. below the water-line, and curves upwards, until, along the middle line of the ship it is but 2ft. below the water-line. It is formed of a ⅝in. steel plate, overlaid by a 2⅝in. compound plate. Below this deck, and between it and the ship's bottom, there are over 50 water-tight compartments. Between the armoured deck and the deck immediately above it there are 100 other water-tight compartments. If, therefore, water were to enter the ship either above or below the protective deck, its volume and evil effects might, with proper precaution, be strictly limited. The chief part of the armament will be carried in two barbettes, one forward and the other aft, on the middle line of the vessel. Each of these barbettes will be plated with compound armour 19in. in thickness, placed at an angle of 24 deg. from the vertical. The ammunition hoists between the armoured deck and the barbettes will also be armoured, and the bases of the funnels will have substantial protection to a height of over 3ft. above the water-line. Beyond this, the vessel will have no armour.

The engines, which are being manufactured by Messrs. Maudslay, are designed to be of 19,500 indicated horse power. They are of the compound triple-expansion type, and are arranged in two sets to each propeller-shaft, so that when the vessel is to cruise under economical steam the forward sets on each side can be disconnected. It is expected that these engines will drive the ship at an extreme speed of 18 knots. The coal capacity of the vessel is 1,200 tons.

The armament of the Re Umberto, in addition to a ram, will comprise four 17in. new model 104-ton Armstrong breechloaders, two being mounted in each barbette; 12 6·1in. Armstrong 4½-ton breechloaders, carried in the batteries; six 3in. guns, and 10 machine and quick-firing guns, together with torpedoes. The so-called 104-ton gun—that is not its exact weight—has a total length of 40ft. 9in., the length of the rifled bore being 28ft. 10 2-3in., and of the powder chamber 7ft. 6in. The number of grooves in the rifling is 80, and they have a twist of 1 in 50 calibres, or, in other words, of one revolution in 70ft. 10in. The full firing charge for the armour-piercing projectile is 900lb. of progressive Fossano powder; for common shell it is 600lb. The projectiles weigh 2,000lb. each. The bursting charge of the armour-piercing projectile is 32lb., of the common shell 60lb. and of the shrapnel 5lb. The muzzle velocity of the gun, when fired with the full charge, is 1,992ft. per second. The muzzle energy is 55,030 foot tons—sufficient to raise the Re Umberto, guns and all, more than four feet out of the water; and the projectile, at the muzzle of the gun, is capable of perforating 33½in. of wrought iron. These heavy guns will be carried at a height of 28ft. above the surface of the water.

CENTRAL ELECTRIC LIGHTING STATION.

For some little time past a building has been in course of erection on the banks of the Thames, at Deptford, which promises to mark an era in the history of electric lighting. The building is the combined engine, machinery, and boiler house for the central lighting station of the London Electric Supply Corporation. The object of the corporation is to supply London with the electric light, and to this end they have laid down lines for the eventual supply of two millions of lights from this great central station, from which they will be able to convey the electric current to all parts of the metropolis. It is, however, for the future to witness the possible completion of this gigantic installation. For the present the corporation is erecting plant and machinery for the supply of 250,000 glow lamps; the building now under construction, however, will be capable of containing the necessary machinery for four times that number.

Before describing this enormous electrical plant, it may be as well to note the small beginnings of which it is the outcome. Some four years since Sir Coutts Lindsay decided to light the Grosvenor Gallery by electricity, and when this became known many in the neighbourhood requested him to enlarge his proposed installation and to supply them with the electric light. This demand went on increasing, until at length a small company was formed and a large central generating station, which is known as the Grosvenor station, was built and equipped. From that station the electric current is now being supplied to some 33,000 lamps, the area covered extending from Regent's Park on the north to the river Thames on the south, and from the Royal Courts of Justice eastwards to Knightsbridge westwards. The whole of this extensive area is effectually supplied with the electric current by five separate circuits. The success thus attained only led to a greater demand for the electric light, and the small company became merged in the present corporation, which consists of a very few subscribers, who have hitherto found the necessary capital among themselves, and intend to find it up to £1,000,000, that being the authorised capital.

The Deptford station is being built on a riverside site of about four acres in extent, known as Stowage Wharf, nearly the whole of which it is expected will be eventually covered by the engine and machinery houses. The buildings at present being constructed occupy a space of 210ft. by 195ft., with a height of about 100ft.

The boiler-house, which is nearest the river, is 195ft. long by 70ft. wide, and is constructed to contain boilers of 65,000 H.P. Of these boilers, which are of the Babcock and Wilcox tubulous type, a number are now being erected, which will supply steam for engines of 13,000 H.P. These boilers are arranged on two floors, the fuel store being on a third floor. The coal will be delivered from the colliers alongside a substantial wharf on the river, and will be run up in trucks by rail to the store, and delivered thence by gravity to the boiler furnaces.

The engine-houses now being built are two in number, each being 195ft. long by 66ft. wide. They are separated from the boiler-house by a wall of masonry, and from each other by iron columns. In the first engine-house a pair of engines of 3,000 united H.P. will be shortly erected.

These engines are of the compound Corliss type, and are being supplied by Messrs. Hick, Hargreaves, and Co., of Bolton, who will supply the other engines and machinery. These engines will drive two Ferranti dynamo machines, each capable of generating the current for 25,000 glow lamps. These will be by far the largest electrical generators that have yet been constructed. They will, however, be greatly eclipsed by the large dynamos which are to follow in the second engine-house. Of these there will be two sets, the dynamos being combined with the engines and driven direct. Some idea of the magnitude of these dynamos will be realised when it is stated that each will weigh 400 tons, and will have an armature 40ft. in diameter.

Each dynamo will eventually be driven by a pair of engines of 10,000 H.P.; but at first only half that power will be developed for driving each dynamo, which will primarily supply current for 100,000 lights. When the time arrives for the creation of more lighting power each dynamo will be driven by the full power of the engine, and each will then supply current for 200,000 lamps. The further anticipated extensions will be carried out on the scale of the larger plant. The details of the undertaking have been worked out by Mr. Ferranti, the engineer to the corporation.

The current—which is known as an alternating current, and is generated at high tension—will be conducted from Deptford to the various parts of the metropolis by mains of a novel contrivance, which will convey the current to a great distance without material loss, and, what is of more importance, with absolute safety, as has been proved beforehand.

The current will be delivered in London at several points, where distributing stations will be established. Here the corporation will have transformers, by which the current will be converted to a lower tension, by which process it will be increased or expanded in quantity very much as compressed vapour is expanded. Thence it will be distributed to the public at a medium tension by other or subsidiary mains, and again finally converted, or expanded, to low tension on the premises of each consumer. In all the arrangements ample provision has been made to guard against any interruption in supply that might be caused by the temporary disablement of any portion of the machinery and appliances.

It is anticipated that before the end of the present year there will be in actual operation at Deptford machinery capable of supplying 50,000 lights, and by the spring of 1889 200,000 more, making, with those already being supplied by the corporation from the Grosvenor station, a total of 283,000 lights.

ALLOYS: THEIR CONSTITUTION AND PROPERTIES.*—I.

As many valuable mechanical properties are conferred upon metals by associating them with each other, it seldom happens that metals are used in a state of purity when they are intended for industrial purposes, and this fact was discovered at a very early period of metallurgical history. The word alloy originally comes, in all probability, from the Latin *ad-ligo* (alligo), "to bind to," and not, as Sir John Pettus thought, from the Teutonic *linderen*, "to lessen," suggestive as it is of the fact that a precious metal is lessened in value by the addition of a base one.

The late M. Dumas eloquently pleaded many years ago against leaving alloys in the oblivion to which modern chemists consigned them, and there still seems to be a prevalent impression that our knowledge of the phenomena which attend the union of metals is very imperfect, and that it rests upon a slender experimental basis. We are apt to forget the extent and complexity of the subject, and Mr. Lupton has opportunely directed attention to the number of alloys which await examination. He says: "Hatchett recommended that a systematic examination of all possible alloys of all the metals should be undertaken. He forgot to remind anyone who should attempt to follow his advice that if only one proportion of each of the 30 common metals were considered, the number of binary alloys would be 435, of ternary 4,060, and of the quaternary 27,405. If four multiples of each of the 30 metals be taken, the binary compounds are 5,655, ternary 247,660, and quaternary 1,013,985."

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* Cantor Lectures, before the Society of Arts, by Professor W. Chandler Roberts-Austin, F.R.S.

Nevertheless, if the properties of many alloys have yet to be investigated, the study of alloys generally has not been neglected. The modern bibliography relating to them is much more extensive than it is usually supposed to be, and the older writings are very full, and contain the results of far more accurate observation than they are credited with. In the early days of chemistry, as its history abundantly proves, alloys received much attention, and although the early chemists often failed to distinguish alloys from simple metals, or used them in unsuitable ways, they left an experimental record, the value of which is sadly unappreciated. From this record it is, incidentally, evident that the development of the art of separating metals from their ores and from each other was quickly followed by the acquisition of the knowledge that metals possess peculiar properties when re-united in certain proportions, and are thereby rendered more useful than they were in the pure state.

In early times some metals were used unalloyed, although at the present day they have no industrial application except in union with other metals. Antimony, for instance, now only employed as a constituent of certain alloys, was formerly cast and fashioned into ornaments, as is proved by the analyses of Virchow, and by a fragment of a very ancient Chaldean vase, which fragment, when examined by Berthelot, proved to be of pure antimony. The implements and ornaments discovered by Schliemann abundantly show that the early Greeks were familiar with alloys of silver and gold, copper and tin, lead and silver, and with many others, all artificially prepared. Throughout the Middle Ages there seems to have been a belief that the action of metals on gold and silver was, on the whole, corrupting; and Biringuccio, in 1540, carefully defined such alloys as being "nothing but amicable associations of metals with each other," and he further pointed out that metals must be mixed by weight, and not at random.

I am not attempting to give the history of research connected with alloys, and I must pass from the 16th to the 18th century, in which we find four writers whose names deserve to be specially mentioned because they seem to have been the first to indicate the direction in which modern investigation has been conducted. These are Réaumur, Gellert, Musschenbroek, and Achard, who respectively studied 1st (Réaumur), molecular change produced in a metal by heat; 2nd (Gellert), the relation of fluid metals to each other considered as solvents; 3rd (Musschenbroek), the cohesion of alloys as shown by certain mechanical properties; and 4th (Achard), the electrical behaviour of metals and alloys. It is interesting to trace the connection between the older work and the new. Réaumur, in explaining the hardening of steel by rapid cooling from an elevated temperature, comes very near the modern view that a metal may, under certain conditions, pass from one allotropic state to another, for he distinctly contemplates the possibility of molecular change produced by the expulsion by heat of "sulphurs and salts" from the molecule into insterstitial spaces between them. He speaks of "molecules and elementary parts of molecules" like a modern writer, and tries to show that when hot steel is rapidly cooled, "sulphur and salts" cannot return into the molecules, but remain in the interstitial spaces, and that therefore the physical properties of hard steel become quite different from those of soft. If it should be urged that the analogy between carburised iron and alloys is overstrained, I would point out that, in 1867, Matthiessen said, after appealing to the fact that in certain alloys the constituent metals are present in allotropic states, "I have always made a comparison between iron and steel (and alloys). This has been done to show that the carbon-iron alloys behave in an analagous manner to other alloys, which cannot be looked upon as chemical combinations."

Gellert makes the analogy of certain alloys to solutions very clear, and in his "Metallurgic Chemistry" he gives a table showing the relative solubilities of metals in each other, while in the observations which accompany it he says, to take one of the cases he gives as an illustration, "Since copper and silver, and copper and gold, dissolve one another very readily, the copper cannot be parted from iron by means of gold or silver," probably having in mind a reaction which enables silver to be parted from gold by the action of sulphur and iron. He further clearly shows that, with regard to the solution of metals in a triple alloy, he understood the possibility of the division of a metal between two other metals acting as solvents.

The mechanical properties of alloys were, as I have said, investigated by Musschenbroek, who, working in the early part of the 18th century, made some experiments on the tensile strength of metals and alloys. He writes of the "absolute cohesion by which a body resists fracture when acted upon by force drawing according to its length," and gives the tenacity of several metals, and the alloys, brass and pewter. He shows the importance of such work so clearly, that it is remarkable how slowly the mechanical testing of metals developed since his time.

Achard, whose researches were published in 1784, made a very extended series of experiments on multiple alloys, as well as those of simple metals. He pointed out that the relative conductivities of substances for heat and for electricity are closely related. He devised an appliance for the experimental verification of this fact, and, as he included alloys in his researches, it may fairly be claimed that he led the way for the important generalisation that alloys may be ranged in the same order as regards their power of conducting heat and electricity, which was made by Wiedmann and Franz in 1853-59.

The necessity of metals being pure when added to each other was hardly recognised until the 18th century, and Dubamel, who contributed the article on alloys to the "Encyclopédie Methodique," in 1792, appears to have been the first writer to insist on the necessity for making exact experiments upon alloys with metals which possess a high degree of purity, and on effecting their union by heat in closed vessels. He further pointed out that up to his time no chemist had taken these precautions, and it is certain that in conducting some modern experiments they have been neglected.

In the early part of the 19th century researches on alloys became more numerous; they were mainly directed to ascertaining the effect on the density of metals produced by alloying them, and to determining the effects of slow cooling on alloys with low melting points. Of such a nature was the work of Ermann in 1827, and of Rudberg (1830-1). Ermann called attention to the peculiar behaviour of alloys of lead and tin when solid. Rudberg studied anomalies in these alloys when in the liquid state.

Regnault showed that the specific heats of certain fusible alloys was greater near 100 deg. than the mean specific heat of their constituents, and this fact appears, as Spring has shown, to have induced Person to undertake researches on the latent heat of alloys, and on their specific heats.

Undoubtedly the greatest work on alloys of the first half of this century was that of Matthiessen, who worked on the electrical resistance of metals and alloys, and who was led to the conclusion that in many cases metals are present as allotropic modifications—that is, in totally different forms from those in which we ordinarily know them.

It is by no means easy to investigate the molecular constitution of alloys, but evidence may be gathered in the following ways:—

1. By comparing the properties of an alloy with those of its constituent metals.
2. By studying the behaviour of alloys in passing from the liquid to the solid state, and conversely in passing from the solid to the liquid.
3. By determining the physical constants of solid alloys, such as their specific gravity, specific heat, electrical resistance, electromotive force, and their mechanical properties, such as tenacity and extensibility.

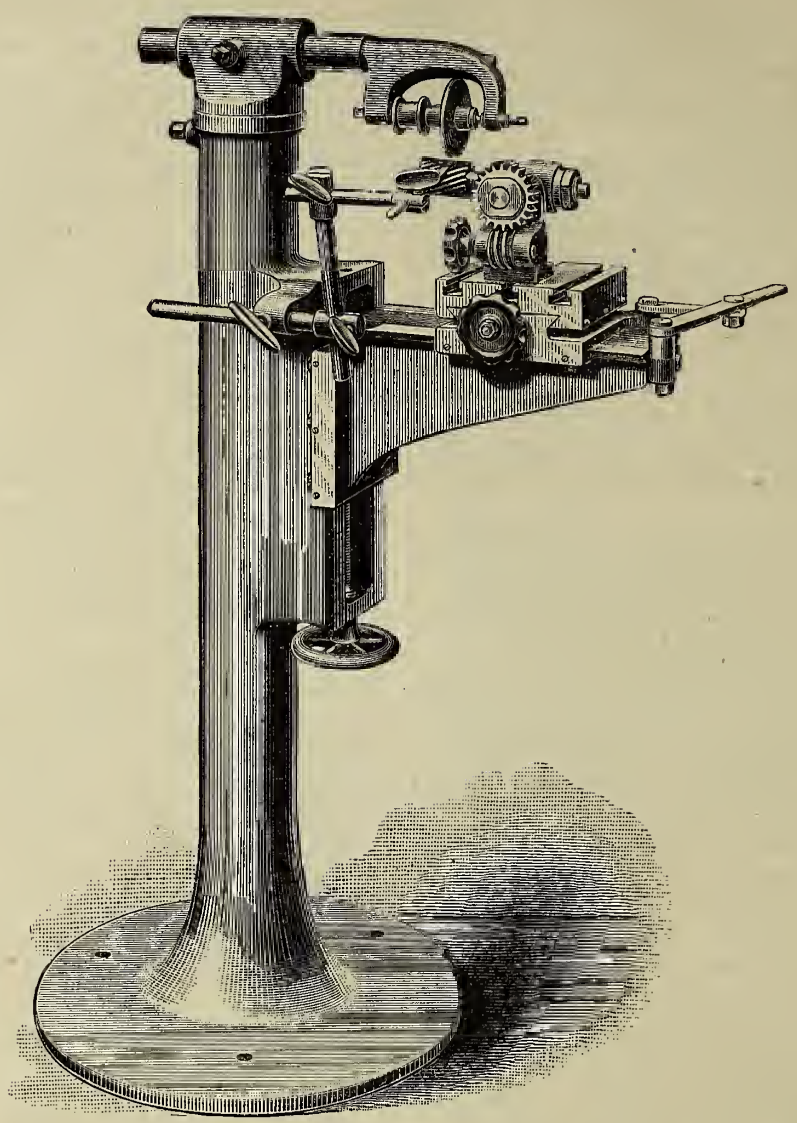
First we must consider the method of producing alloys, for the union of metals may be effected in three ways:—

1. By fusion—that is, by causing metals to unite by melting them together.
2. By compression of the powders of the constituent metals.
3. By electro-deposition.

The first method, by fusion, is of course the method ordinarily adopted. One of the metals is melted, and the other is added to it, sometimes in the fluid, state but often in the solid. In the experiment now in progress we are taking a simple case, by melting tin and adding arsenic to it, the arsenic being added in small quantity; but the product—the alloy—will have very different properties from those possessed by either of the constituent metals. Its fracture closely resembles zinc, and is as different as possible from that of either tin or arsenic. Every metal has, of course, a definite melting point, but, apart from the heat initially required to melt a metal, we find that the union of metals is sometimes attended with an evolution, and sometimes with an absorption of heat.

(To be continued.)

UNIVERSAL MILLING CUTTER SHARPENING MACHINE.



The illustration given above represents a machine which has been designed by Messrs. J. Spencer and Co., of Chamber Ironworks, Hollinwood, near Manchester, for the purpose of sharpening various kinds of milling cutters after they have been hardened, and will be found of great service in all shops where shaping with milling tools is carried on to any extent.

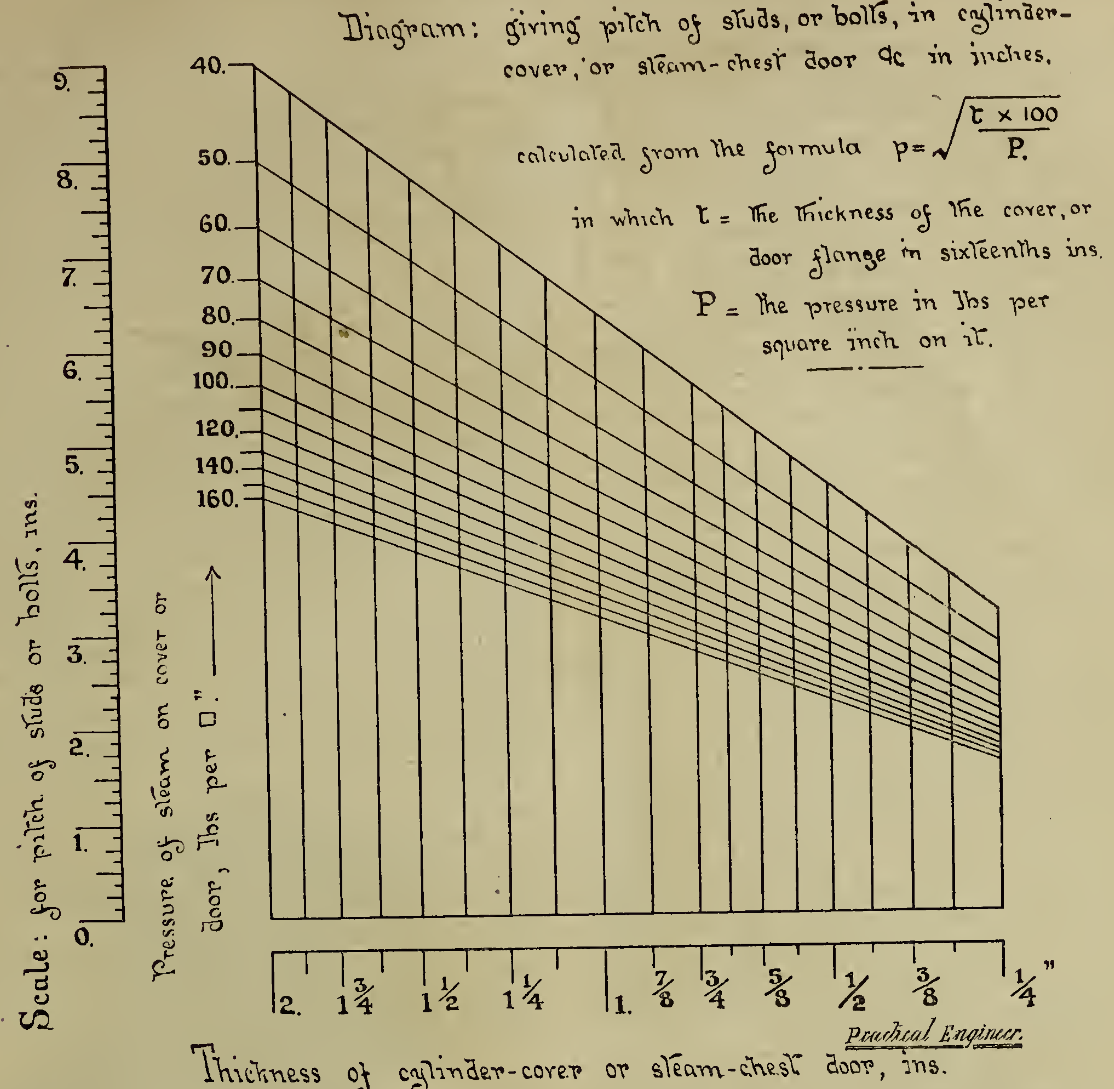
The machine will grind parallel or taper cutters up to 7in. in diameter, with a width of 6in. on the face, and with the teeth cut either straight or spiral. The head holding the emery wheel spindle is mounted on a pillar, and can be adjusted to various positions to suit the work. The pillar, as will be seen, is fitted with an adjustable bracket or table, which can be raised or lowered by means of a screw actuated by the hand wheel shown at the bottom of the slide. On the upper surface of the bracket is another small table, which can be moved in or out from the centre of the pillar by means of the lever shown at the end of the bracket, or in a direction at right angles to this, by means of the hand nut shown at the side. Adjustable stops are provided, as shown in the engraving, so that the traverse of the small table actuated by the lever may be regulated in both directions. The appliance for chucking the cutters consists of a small headstock bolted to the upper surface of the small table referred to, which is fitted with planed T grooves for this purpose. The headstock contains a socket for holding mandrels of various diameters to suit the cutters, while the mandrel may either revolve freely in its bearings, or it may be gripped tight while the cutter revolves on the mandrel, as circumstances may require. The socket may also be made to rotate, if desired, by means of the small worm and wheel shown at the side. This arrangement permits of the cutters being very finely adjusted either for grinding perfectly parallel or to any desired angle.

The cutter to be ground is set so that the traverse given by the hand lever causes the whole length of the tooth to come under the operation of the emery wheel; this is easily effected by means of the various table adjustments. The pall is then fixed against the edge of the tooth to be ground, each tooth in turn being brought to bear against it, and passed under the emery wheel. By this means a uniform keenness is imparted to every tooth of the cutter, which is thereby ground perfectly true, even though the teeth themselves be irregularly spaced.

The machine is very compact, while the workmanship and finish are everything that could be desired.

Danger in Cleaning Gas-fired Boilers.—A fearful accident occurred at the Cyfarthfa Works, Merthyr, on Sunday afternoon. Some men were engaged in cleaning a boiler when they were overcome and suffocated by gas which had escaped through an aperture communicating with the blast furnaces. Six or seven men, some of whom had gone to the assistance of the others, were ultimately brought out by workmen who bravely went into the boiler with ropes attached to them. The work of resuscitation was proceeded with, the result being that after a great deal of effort three or four men were restored to consciousness. In three cases the efforts were quite unavailing. The boiler was heated by the waste gases from the blast furnaces, and the disaster is said to have been due to the dampers which regulated the supply of gas having been incautiously left open.

PITCH OF STUDS FOR CYLINDER COVERS AND VALVE CHESTS.



The above diagram of pitch of studs or bolts in cylinder covers or steam chest doors is one which will be found useful when designing cylinders, giving as it does graphically the greatest allowable pitch in inches of the studs or bolts in cylinder cover or valve box door flanges, of from ¼in. to 2in. thick, under pressures ranging from 40lb. to 160lb. per square inch. The formula on which the diagram is based is that given in Seaton's "Manual of Marine Engineering," viz.:

Pitch in inches not to exceed $\sqrt{\dfrac{t \times 100}{p}}$

when t = Thickness of cover or flange in sixteenths of an inch,
p = Pressure of steam in pounds per square inch.

To illustrate the use of the diagram, suppose it is required to know the greatest pitch that may be given to the studs in a steam chest door flange ½in. thick, the working pressure of steam being 50lb. per square inch. With a pair of compasses measure the length of the ordinate at the point marked ½in. on the scale of thicknesses from the base line to the line marked 60lb. on the scale of pressures; transferring this to scale for pitch of studs to left of diagram, read off 4in. as greatest pitch, or by the formula—

$$p = \sqrt{\frac{8 \times 100}{50}} = 4\text{in.}$$

This pitch may have to be altered to suit the number of bolts, but should never exceed that given by the diagram.

The diameter of the bolts may be found as follows: Multiply the area of the cover in square inches on which the steam acts by the pressure of the steam in pounds per square inch, and divide the produce by the allowable working strain in pounds per square inch on the bolts, which gives the total effective bolt area required. This, divided by the number of bolts due to pitch, gives the area of one bolt; when the diameter can be found from the appended table.

For example, take the case of a steam chest door, the area on which the steam acts being 360 square inches, and the pressure of steam being 100lb. per square inch.

Thickness of flange 1⅛in.
Pitch of studs from diagram 4$\frac{3}{16}$in.
Number of studs 25.
Safe working strain on bolts taken at 4000lb. per square inch.

Total bolt area $= \dfrac{360 \times 100}{4000} = 9$ sq. in. and $\dfrac{9}{25}$ = effective area of one bolt, or ·36 square inches, and taking the nearest to this from the table, we get ⅞in. as the diameter of the studs, which gives ·42 square inches area at bottom of thread; or by reducing the pitch to 4in., and thus increasing the number of studs from 25 to 30, we should get a better result, for $\dfrac{9}{30} = {·}3$ as the effective area of one bolt, which we see from table corresponds with a ¾in. bolt exactly.

TABLE OF EFFECTIVE AREAS, &C. OF BOLTS.

Diameter of Bolt.	No. of Threads per inch Whitworth.	Area at Bottom of Thread.	Load at 4000lb. per sq. inch.
⅜in.	16	·0683	273
$\frac{7}{16}$in.	14	·0940	376
½in.	12	·1213	485
⅝in.	11	·2026	810
¾in.	10	·3038	1215
⅞in.	9	·4208	1683
1in.	8	·5541	2216
1⅛in.	7	·6989	2795
1¼in.	7	·8941	3576
1⅜in.	6	1·058	4232
1½in.	6	1·3	5200

INFLUENCE OF FLANGED SEAMS ON THE STRENGTH OF FURNACE TUBES.—IV.

(Concluded from page 512.)

A consideration of the results of the experiments suggests several interesting points for comparison. Although it may be true, as stated in the memorandum, that furnace tubes strengthened with flanged seams are now "seldom used for marine boilers," yet they are very widely adopted in land practice, especially in boilers of the Lancashire and Cornish type, so that the question how far furnace tubes of this description compare with plain unstrengthened tubes, and whether any and what limits exist with regard to the adoption of flanged seams for modern high-pressure, becomes of considerable interest to all makers of land boilers. As most readers will be aware, it is desirable in a furnace tube to keep down the thickness as much as possible. If the tube were called upon simply to resist external pressure, the question of strength could be easily met, but the action of the fire introduces an element which is not so easily dealt with, and which renders it desirable, if overheating and straining are to be avoided, that the thickness shall not exceed certain limits.

The strength of the tube cannot in any case, of course, exceed that which is determined by a consideration of the crushing stress imposed on the material, and it is important to note that in this respect the furnace tube used in the experiments compared very favourably with corrugated tubes of similar thickness. The Board of Trade rule for steel corrugated furnace tubes is that shown in formula (3), in which the constant C = 12,500, and it will be seen on reference to Table No. 8 that the constants for the experimental tube, derived from the results of the tests, were in the case of the rings A, C, and D actually in excess of this, while the falling off in the case of ring B was only very slight. In other words, the working pressures for the various rings deduced from the experiments, and given in Table No. 9, are in three cases out of the four greater than would be allowed by the Board of Trade rule for a corrugated flue of equal thickness. It will, of course, be manifest that if the flanged seams be placed too far apart the strength of the tube will be affected by other considerations, and cannot be determined by a reference to the crushing stress of the material alone. A question of considerable practical importance therefore arises as to what is the greatest distance at which the flanged seams may be placed apart, in order to secure that the strength shall still be determined by crushing. On this point the memorandum throws a little light, though hardly as much as could be wished. For, on reference to formula (4), it will be seen that the maximum length of the ring in inches allowed is represented by the expression

$$L = (135 \times \text{thickness of tube}) - 12.$$

No information is given with regard to the data on which this value of L is based, but accepting the expression as given, it appears to us that formula (4), which is designed to meet cases in which the flanged seams are pitched more closely together than would be represented by the expression for L above, is hardly consistent with the results of the experimental tube. Our meaning will be more clear if we compare for a moment formula (4) with formula (3), which, taking C = 12,500, represents the working pressure which would be allowed for a steel corrugated furnace tube, thus:

$$\frac{12500 \times T}{D} = W\,P.$$

This formula is, of course, identical with the following:

$$\frac{(13830 - 1330)\,T}{D} = W\,P.$$

And since $1330 = 5030 \times \frac{1}{3{\cdot}77}$ the formula may also be written,

$$\frac{\left(13830 - 5030 \times \frac{1}{3{\cdot}77}\right)T}{D} = W\,P \quad (6)$$

This expression, it will be seen, is similar to formula (4), and is equivalent to stating that when the flanged seams are pitched at $\frac{1}{3{\cdot}77}$ the maximum distance permitted, according to the expression given for L above, the working pressure allowed by the Board of Trade is equal to that granted to a corrugated furnace tube of the same thickness, which is allowed a working crushing stress of $\frac{1250}{2}$ = 6250lb. per square inch. For intermediate pitches the working pressure would still be determined by a reference to crushing alone, but the stress thus allowed would be a little less than 6250lb. If these rules be applied to the experimental tube, we find that the maximum pitch apart of the flanged seams, for a thickness of ·54 inches—

$$L = (135 \times {\cdot}54) - 12 = 61 \text{ inches};$$

and according to formula (6) the pitch would require to be reduced to $\frac{61}{3{\cdot}77}$ = 16 inches before the flanged seam was placed on the same footing as the corrugated flue. Yet the results of the tests showed that with the flanged seams pitched as much as 23 inches apart the constants in Table No. 8, as well as on the working pressures in Table No. 9, were actually higher than would be allowed for corrugated flues of the same thickness.

In other words, whereas the experiments showed three of the rings of the flue, per Table No. 9, to be equal to a working pressure of 161·5lb. per square inch, the application of the formula (4) to the same tube would only allow a working pressure of about 150lb. The difference, it is true, is not great, and we fully realise the difficulty of framing a rule which will meet every case. Our main object in calling attention to the discrepancy between the rule and the result of the actual experiments is to point out that flue tubes, strengthened with flanged seams, are, if anything, stronger than is indicated by formula (4).

As it is sometimes asserted that the application of Board of Trade rules would prevent almost every land boiler from being worked at the pressures generally adopted, it may be of interest to consider for a moment the application of formula (4) to the case of a Lancashire boiler, say 7ft. 6in. diameter for a working pressure of 100lb. on the inch. The flues for such a boiler would be, as nearly as may be, 3ft. in diameter, and made of plates $\frac{7}{16}$in. thick, the flanged seams being, as a rule, pitched about 3ft. apart. Applying formula (4) to such a case, we find the Board of Trade, for such a furnace tube, would allow a working pressure of 120lb. per square inch as nearly as may be, or 20 per cent more than is adopted in ordinary practice.

In Table No. 10, the memorandum institutes a comparison between the actual collapsing pressure as found by experiment with that deduced by Fairbairn's formula, but as the application of that formula without any regard to crushing stress is simply absurd, we can only conclude that the writer of the memorandum is poking fun at someone, and trust the joke may find its way to the proper quarter. The absurdity of applying Fairbairn's rule to furnace tubes of such short length is certainly very strongly emphasised, and we trust the illustration so forcibly drawn will not be lost.

In conclusion, we cannot refrain from expressing on behalf of at least a portion of the engineering profession our obligations to the Marine Department of the Board of Trade, for the valuable addition which the experiments constitute to our stock of knowledge regarding the strength of furnace tubes.

NORTH STAFFORDSHIRE INSTITUTE OF MINING AND MECHANICAL ENGINEERS.

A meeting of this institute was held at Birmingham on Thursday, the 25th ult., in order that the members might have an opportunity of inspecting the works of the Birmingham Compressed Air Power Company in that town, and discuss a paper on the subject which was read some time ago at an ordinary meeting at Stoke, by Mr. J. Sturgeon.

These works have only just been got into practical operation, and are the first of the kind in the kingdom. The object of the scheme is to substitute compressed air for steam for driving the numerous small or moderate sized engines in a district.

The air is compressed to a pressure of four atmospheres by large air-compressing engines worked by steam at a central station, and conveyed in mains through the central streets of the district, and from these mains service pipes are taken to the various power users, an Act of Parliament having been obtained to enable this to be done. From the delivery branch of the compressors the mains are of wrought iron, ranging from 24in. to 47in., the operations at present being confined to three wards.

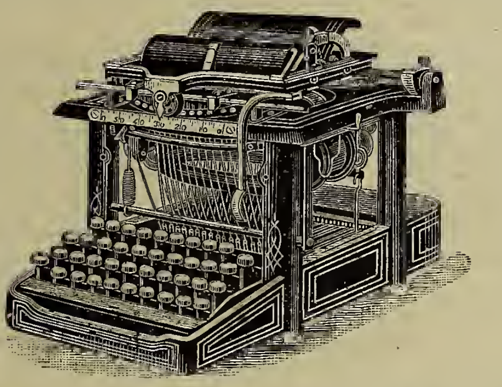
The generating works are calculated for the production of a maximum of 15,000 H.P., but at present the machinery is limited to six sets of compressing engines, each set being equal to 1,000 H.P. Each set, fitted with a single-acting air cylinder, is capable of delivering 2,000 cubic feet of air per minute at a pressure of 45lb. per square inch, and the boilers are heated by gas generated by thirty-one of Wilson's patent gas producers.

The compressed air is supplied to consumers by meter. As the air mains are tested under a head of water of 600ft., and have at least 3ft. of earth over them, the danger from the fracture or explosion of a main should not be serious. The principal check consists of valves fixed at convenient intervals, and so constructed that in the improbable event of the bursting of a pipe the rush of air to the breach will carry the adjacent valves up to their seats, and so shut off the broken section of the main from the rest of the system, thus preventing any general interruption of the supply.

It is now considered that all mechanical and other difficulties have been overcome. The advantages of the system are very numerous, and include driving ordinary rotary steam engines, steam hammers, Tangye pumps, and direct-acting engines; supplying air to furnaces, working air gas apparatus, driving dynamo machines, and various methods of propelling. Existing engines can be used, and much cost may be saved in opening new works, while the system saves inconvenience from smoke and other causes.

IMPROVEMENTS IN TYPEWRITING MACHINES.

These ingenious labour-saving appliances are coming very rapidly into use in this country, and promise soon to become as popular here as in the United States. As our readers will be aware, there are several kinds of typewriters, but that known as the Remington has been demonstrated to possess such marked superiority over its rivals that it bids fair to entirely supplant them in the public favour. We are informed that the sales last year alone of this little machine amounted to upwards of 14,000. The rapid increase that has lately taken place in the adoption of mechanical writing machines is doubtless due in a large measure to the various improvements that have been effected within recent years. In no case have the improvements been more marked than in the Remington machine, the result being that it is now a really practical instrument, capable in the hands of a good operator of performing an amount of work which would some time ago have appeared incredible, and, indeed, would otherwise have been impossible.



The history of the typewriter, like that of the sewing machine and other labour-saving inventions, is a record of gradual evolution; of slow but sure improvement; and, like them, its perfection has been the result of long years of labour on the part of more than one man.

The career of the typewriter dates back little more than a decade, and it is, comparatively speaking, in its infancy as compared with the sewing machine. There are not a few persons, however, who place the two inventions side by side in future importance, and an eminent writer has rather aptly remarked "that the typewriter is to the pen what the sewing machine is to the needle." With the aid of this little instrument an operator can accomplish more correspondence than could be got through by several clerks, while the resultant work has the inestimable advantage in business correspondence of being perfectly clear and legible, thereby not only saving the time of the recipient, but also avoiding the ambiguity and uncertainty that too frequently occur with ordinary caligraphy. As we have already stated, the invention is about ten years old. It was not, however, until 1882 that the capacity of the instrument had become fully developed and its possibilities rendered unmistakably apparent. The typewriter of to-day is undoubtedly a marked improvement upon that of 1874. In the early machine only capital letters were used, while these were more or less liable to get out of order.

The construction of the present Remington, shown in the accompanying illustration, is so well known that a detailed description is perhaps hardly necessary. The type arms or bars, each carrying a "lower case" letter with its corresponding "capital," are thrown up by the ordinary pianoforte lever action. Each impression also causes the frame carrying the rollers holding the paper sheet to move through one space, thus putting the paper into correct position for the next letter. It may be stated that the types are of tempered steel, and thus practically indestructible. The perfection of the mechanical construction of the machine, as well as its delicate adjustment and freedom from strain, is perhaps best attested by the fact that experts have been able to give clear impressions of a letter at the rate of 13 per second. One of the most important improvements that has been effected has been the introduction of "capital" and "lower case" letters without increasing the number of keys.

The saving in time that it is possible to effect by means of a typewriter may be best illustrated by a reference to one or two of the typewriting contests that have taken place in the United States between the Remington and its rivals. In one of these the conditions of the contest were that 45 minutes were to be devoted to writing from dictation, and 45 minutes to writing from copy read by the operator. At the end of the contest it was found that the operator of the Remington, which proved successful, had written from dictation 4,294 words, or at the rate of 95½ per minute; while from copy he had transcribed no less than 4,415 words, or rather more than 98 per minute for 45 consecutive minutes. The performance was certainly a brilliant one—even with a typewriter—and illustrates more forcibly than anything we can say the capacity of the machine and the extent to which it may be developed in the hands of a skilful operator.

THE ELECTRICAL TRANSMISSION OF POWER—II.

(Continued from page 514.)

Until 1870 the generator most generally employed for obtaining electricity and giving it pressure was the galvanic battery, scientifically an extremely efficient converter of the energy in fuel into electric energy; but, unfortunately, the only fuel a battery will burn is expensive. A very perfect fireplace, in which there was very complete combustion and very little loss of heat, but which had the misfortune that it would only burn the very best wax candles, would be analogous with a battery. The impossibility of using zinc as fuel to commercially work electromotors has been known for the last half century, and the matter was very clearly put in an extremely interesting paper, "On Electro-Magnetism as a Motive Power," read in 1857 by Mr. Hunt before the Institution of Civil Engineers. Sir William Thomson put the matter very pithily by showing that even if it were possible to construct a theoretically perfect electro-motor, the best that could be hoped for, if it worked with a Daniell's battery, would be the production of 1 H.P. by the combustion of 2lb. of zinc per hour, whereas with a good actual steam engine of even thirty years ago 1 H.P. could be produced by the combustion of exactly the same weight of the much cheaper fuel, coal. This argument against the commercial employment of zinc to produce electric currents is irresistible unless—and this is a very important consideration which is only beginning to receive the attention it deserves—unless, I say, the compound of zinc formed by the action of the battery can be reduced again to metallic zinc by a comparatively inexpensive process, and the zinc used over and over again in the battery. If the compound of zinc obtained from the battery be regarded as a waste product, then it would be much too expensive to work even theoretically perfect electromotors if they were existent by consuming zinc. Suppose, however, a process be devised by means of which burnt zinc can be unburnt with an expenditure comparable with the burning of the same weight of coal, then it might be that although coal would still form the basis of our supply of energy, the consumption of zinc batteries might be an important intermediary in transforming the energy of coal economically into mechanical energy.

While, then, some experimenters are aiming at possibly increasing the working power of a ton of coal to eight times its present value by earnestly seeking for a method of converting the energy without the intervention of a wasteful heat engine, it should not be forgotten that in the cheap unburning of oxidised metal may lie another solution.

The solution of this latter problem is quite consistent with the principles of the conservation and dissipation of energy, since the heat required to theoretically unburn 1lb. of zinc is only one-seventh of that given out by the burning of 1lb. of coal. Further, it involves no commercial absurdity like that found in the calculations given in the prospectuses of many primary battery companies, which are based on zinc oxide, a material used in the manufacture of paint, maintaining its present price even if thousands of tons were produced. Unless all those who use primary batteries on this expectation intend to have the painters doing up their houses all the year round, they will find themselves possessed of the stock-in-trade of an oil and colourman on a scale only justified by a roaring business in paint.

Now about waste No. 3, the waste of power at the motor. That also is gone into fully in the discussion in Mr. Hunt's paper, and Mr. Robert Stephenson concluded that discussion by remarking that "there could be no doubt from what had been said that the application of voltaic electricity in whatever shape it might be developed was entirely out of the question, commercially speaking. . . . The power exhibited by electric magnets extended through so small a space as to be practically useless. A powerful electro-magnet might be compared for the sake of illustration to a steam engine with an enormous piston, but with an exceedingly short stroke. Such an arrangement was well known to be very undesirable." And this objection, made with perfect justice against the electro-motors of thirty years ago, might also have been made to all the machines then existing for the mechanical production of electric currents.

A very great improvement in electric motors was made by Pacinotti in 1860, but although his new form of electro-motor was described in 1864, it attracted but little attention, probably because any form of electro-motor, no matter how perfect, was commercially almost useless until some much more economical method of producing electric currents had been devised than the consumption of zinc and acids. Pacinotti's invention removed from motors that great defect that had been so fully emphasised by the various speakers at the reading of Mr. Hunt's paper in 1857. When describing his motor in the *Nuovo Cemento*, in 1864, he pointed out that his principle was reversible, and that it might be used in a mechanical current generator. This idea was utilised by Gramme in 1870, who constructed the well-known Gramme dynamo for converting mechanical into electric power, a machine far more efficient than even Pacinotti had contemplated, and gave the whole subject of electrical engineering a vigorous forward impulse. Every subsequent maker of direct current dynamos, or motors, has followed Gramme's example in utilising the principle devised by Pacinotti, which was as follows: In all the early forms of dynamos or motors, there were a number of magnets and a number of coils of wire, the magnets moving relatively to the coils, or the coils relatively to the magnets. To produce magnetism by a large number of little magnets is not economical, and Pacinotti's device consisted in arranging a number of coils round a ring so that all could be acted on by one large magnet. Instead of frittering away his magnetism, Pacinotti showed how it could be concentrated, and thus he led the way to dynamos and motors becoming commercial machines. Pacinotti's science, engineered by Gramme, not only made electric lighting commercially possible, but led to electricity being used as a valuable motive power. It was in their work that the electric transmission of power in its modern sense sprang into existence.

Quite recently an improvement in the same direction has been introduced into alternate-current dynamos by Mr. W. N. Mordey, for he has replaced the many magnets of the ordinary alternate-current dynamos with one large magnet, and so with his alternator, weighing 41 cwt., he has succeeded in obtaining at a speed of 650 revolutions per minute an output of 53·6 horse power with a high efficiency.

Eighty-seven and a half per cent of the power put into an Edison-Hopkinson dynamo has actually been given out by the motor spindle when 50 horse power was being transmitted. How does this compare with the *combined* efficiencies of an air pump and an air motor, or of a water pump and a water motor? I understand that in either of these cases 60 per cent is considered a very satisfactory result. As far, then, as the terminal losses are concerned, electric transmission of power is certainly superior to air or water transmission.

(To be continued.)

London Chamber of Commerce and Electrical Trades.

A meeting was held at the offices of the London Chamber of Commerce, Eastcheap, on the 22nd ult., for the purpose of completing the organisation of the electrical trade section of the chamber. A report was brought up, in which it was recommended that a working or executive committee should be charged with the ordinary business of the section. With a view to an equitable representation, the report, which was finally adopted, recommended the division of the working committee into the following subsections: Telegraph companies, five members; telephone companies, three members; electrical supply companies, six members; electrical manufacturers and contractors, thirteen members; consulting electrical engineers, four members; and "general," two members.

CORRESPONDENCE.

We do not hold ourselves responsible for the opinions of our Correspondents.

FIRING OF MILL CHIMNEY.

To the Editor of "The Practical Engineer."

Sir,—The following experience of the writer many years ago will doubtless be of interest to your querist "L.," who described, in last week's *Practical Engineer*, how his chimney "fired," and desires to hear of any similar instance having occurred.

Two Lancashire boilers not hard fired were worked on the "charging" or "coteing" plan; that is, the firing was by heavy charges, the fires being kept as thick as possible (within two or three inches of the furnace crowns, in fact), and the combustion regulated by the dampers, which, as a rule, were kept almost closed, alternate firing being practised, and the production of black smoke being, by this plan, almost entirely prevented by hand firing.

The boilers had been worked in this way for years with coal of fair quality from a local colliery, when, owing to a strike in the district, some very hot, fiery, or gaseous coals of a totally different character to what were ordinarily supplied were used on the boilers. On the occasion in question the four furnaces were all heavily charged with fuel, and the dampers had been down some time. As the steam pressure began to fall, the dampers were raised, when flames were seen to burst out from the top of the chimney stack, and flakes of red-hot burning soot were deposited all over the neighbourhood, causing considerable alarm. It was supposed at the time, that whilst the dampers were closed the flues must have become filled with carburetted hydrogen or other gas, distilled from the coteing coals, which, when it became mixed with the proper quantity of air on the opening of the dampers, burst into flame with explosive force, setting fire to the soot in the chimney. This occurred on two or three occasions during the use of the same quality of coal, but never on any other occasion.

The circumstances detailed by "L." appear to be somewhat different to those which obtained in the case above mentioned, as he states that the chimney fired after the fires were drawn and the dampers had been closed, whereas in the instance I have described the firing of the chimney seemed to occur almost invariably on the opening of the dampers and breaking up the fires.

There is, of course, always an accumulation of soot beyond the flues proper on the chimney shaft, and the writer has frequently met with it red hot just beyond the main damper, as well as in the upper parts of the side flues, and wanting only a little more oxygen to fan it into a state of vivid combustion or incandescence. It is possible, therefore, that there has been an inrush of air at some part of the flue just beyond the damper, perhaps down the damper frame itself, which is very frequently the case, as may be heard by the whistling noise it makes; and when the dampers have been closed, and air thus prevented entering at other parts, the rush of air at this particular part has been so much intensified as to become like a sort of blast or jet, and thus blowing directly on some red-hot soot would be quite sufficient to fan it into a state of active combustion, and thus fire the chimney. This would quite explain the phenomenon referred to. "L." will find some further information on this particular subject in the article which appeared in No. 11 of *The Practical Engineer* of May 13th, 1887, on "Flue Explosions."—Yours, &c., Azim.

RAILWAY HEROES.

To the Editor of "The Practical Engineer."

Sir,—I have been cogitating over the account of the sad deaths of the two railway employés on the foot plate, which was described in your last issue, and desire enlightening on one or two incidents connected therewith. It is an old saying that "It's easy talking after the thing is done," yet I cannot comprehend how the driver and fireman were exposed to such a stream of fire and steam if the fire door was shut; and if not shut, why not? By the route the train was taking, from Leeds to Manchester, I presume it would be a London and North-Western one, drawn by one of their main line tender-coupled engines. This engine would have the dished, swinging fire door, hinged at the top, and opening upwards inside the fire box by means of a handle at the driver's right hand. This door, if closed, would be sufficiently tight to prevent an excessively dangerous outrush of steam when the fire box was pierced by the broken connecting rod. There would be an outlet for the water and steam through the fire bars, ash pan, and damper; also through the tubes into the chimney. Supposing fire door was open, could it not have been instantly closed by the driver? and why should he have to keep crossing the line of fire to manipulate the brakes? The only brake he could cross the foot plate to is the tender hand-brake, and this would be unnecessary for he would have his automatic brake-handle, which lies horizontally at shoulder height, in front of him, and which applies brake on engine, tender, and train. Could he not have jerked this on, and retreated on the tender with his fireman until the train came to a stand? I am not wanting in veneration or respect to the memory of the poor fellows, nor do I wish to unjustly criticise their last actions. "*De mortuis nil nisi bonum.*" Yet a further practical detailed description of the accident would be of service and interest (if your correspondent has the means of kindly supplying it) to many of your readers, as well as to yours truly, An Amateur.

A VARYING COAL CONSUMPTION.

To the Editor of "The Practical Engineer."

Sir,—The circumstances mentioned by "Chief Stoker" in his query in last week's *Practical Engineer* are not by any means an unusual experience, and it is not always an easy matter to determine why, when working some boilers, the coal consumption is much heavier than when others are worked, apparently under the same or very similar conditions. The new boiler, by the use of which, in place of one of the old boilers, the coal consumption is increased by as much as five tons per week, I note is 7ft. 6in. diameter, is nearest the chimney, and has the best draught. Thirty-five tons, or even forty tons per week (I presume of from 56 to 60 hours), is not a heavy consumption for three such boilers. It has been found in recent years, since larger boilers of steel have come into such general favour, that a 7ft. 6in. Lancashire boiler is capable of performing with comparative ease something like 25 per cent more work than a 7ft. boiler of the same length. The furnaces are larger, and although the grate surface is perhaps not more than 10 per cent greater, combustion appears to be more readily effected. It is hence possible, if the larger boiler is so much larger for its work, that the stoking of this boiler is not so carefully attended to as it might be. If, for instance, "thin-firing" is in vogue—if the dampers are kept continually wide open, and firing is not very frequent, owing to the work being comparatively easy, the bars will become bare in places from time to time, and, if this occurred frequently, the inrush of cold air, and consequent cooling of the furnace plates, would be quite sufficient to account for the increased coal consumption. Where the firing is easy, heavy firing should be resorted to, the fires being kept as thick as possible, and the combustion regulated by the dampers, which for the greater part of the time should be kept partially closed. The 7ft. 6in. boiler would be capable of burning, without difficulty, 25 tons of coal per week, and one of the other boilers could manage the other 10 or 15 tons; hence I would suggest that "Chief Stoker" try the effect of working only one of his old boilers along with his new 7ft. 6in. boiler, and give the result of the experiment for the benefit of the readers of *The Practical Engineer*.—Yours, &c.,

Mechanical Engineer.

FUSIBLE PLUGS.

To the Editor of "The Practical Engineer."

Sir,—Having during the last few years had opportunities of testing nearly every plug in the market, I am prepared to say (at the risk of being accused of partiality) that too much cannot be said in favour of the protector flange. My mode of testing plugs that have come to hand has been by placing them on a hot plate, and in most of the cases where there has been no protector flange the alloy has gradually run away, bit by bit, in many cases allowing the cone to cant over and lock itself fast; while in every case the protector flange has prevented the alloy escaping until it was all fused, and then allowed the alloy and plug to fall away together.—Yours, &c., Straightedge.

Oct. 30th, 1888.

QUERIES AND REPLIES.

Length of Carriage Spring.—Can you oblige me with a rule for finding the length of steel required for the back of a carriage spring, the length being given across top, and the height to which it is bent?—W. H.

Answer.—We presume from your query that the spring is bent to the arc of a circle, the length of which can be easily found from the data given. The rule is to square half the distance across; add this to the square of the height; and divide by the height. For example: If half the distance across equals a inches, and the height equals b inches, then the length of the arc of the circle in inches $= \frac{a^2 + b^2}{b}$

Incrustation in Surface Condenser's Tubes.—Can any reader inform me how to remove the incrustation from the inside of the tubes of a surface condenser of a land engine? The deposit is very hard and tenacious, and consists almost entirely of carbonate of lime.—Nemo.

Joy's Valve Gear.—Can any of your readers tell me how the valves are set in an engine when Joy's valve motion is adopted? Also, how to get the lead of valve? Suppose a valve to have ⅛in. lead, and it is desirable to increase it to 3/16in., how would you operate?—G. H.

Ventilation of Mine.—May I take the liberty of asking the following questions through your paper: A section of workings in a pit is connected to some old waste workings where much inflammable gas is given off. If compressive ventilation is adopted, would it have any advantage over that caused by an exhaust fan? Further, can any reader give me a good rule for finding the amount of "draw" to allow when approaching buildings, so that they may not be damaged, first under ordinary circumstances, and also when there is soft material near the surface.—T. H. W.

Anti-incrustation Composition.—Referring to the letter by "B. J. T." in your last issue, I should be glad if he would kindly inform me where the composition in question may be obtained.—J. L. Y.

Specific Gravity of Sea Water.—I should feel much indebted for assistance from you or any of your numerous readers with the following question: A vessel, consisting of a pipe closed water-tight at each end by pistons, which slide inside the pipe, thereby increasing or diminishing the total volume, floats 9/10 vol. submerged in sea water, when expanded to its greatest extent. By the addition of a certain quantity of sea water the vessel is sunk just under the surface of the water. By means of the pistons its volume is now diminished, causing it to sink. Required, the proportion of this diminution to the total original volume per 100 fathoms sink? Also, How does the specific gravity of sea water vary on an average with the depth from the surface, and between what limits?—Janey.

Plumbago Crucibles.—I should be obliged if some correspondent would kindly inform me what is the composition which is used in the manufacture of black lead or plumbago crucibles.

Diagram of Stress for Girder.—I should be obliged for any information regarding the most correct method of setting out a parabola for a uniformly-loaded straight girder, supported at both ends, showing line of stress and how to fix length of plate by same. One method I know is to draw the flange plates full size vertically, and make the central vertical line equal to the height thus obtained. But is there not another method of setting up the centre vertical line by taking the areas of the plates and angle irons consecutively?—Gyrtona.

Helical Wheels.—Can any of my fellow-readers inform me of the best mode of setting out the teeth of a pair of bevel helical wheels, the larger wheel to be 34·8in. diameter, with 6in. face and 73 teeth, 1½in. pitch, and the smaller one or pinion 18·14in. diameter, with 6in. face and 38 teeth 1½in. pitch? Also a plain spur wheel 77·98in. diameter, with 140 teeth, 1¾in. pitch, to work in a pinion 40·1in. diameter, with 72 teeth. Any information with regard to making the patterns would oblige.—J. W. J.

Would some reader kindly inform me what is the proportionate strength of helical wheels in comparison with spur wheels having similar diameter, pitch, and face; also what is the rule for finding the breaking strength of helical wheels?—W. R. E.

Weighing Machines.—Is there any book published dealing specially with the construction of these machines, and what is the price?—T. D.

Chilled Furnace Bars.—Can any of your readers give me any information with regard to chilled furnace bars? To what depth can they be chilled from the top surface? Is it difficult to cast chilled bars any length—say 6ft.? What difference does it make in the nature, temperature of fusion, and also cost as compared with ordinary furnace bars?—Durability.

Hoppers for Grinding Mills.—Having a number of hoppers to make for a grinding mill, I shall be obliged if some reader would give me a rule other than rule of thumb for finding the proper bevil to plane the corners to.—A Country Millwright.

Hydraulic Ram.—Can any reader oblige me with a sketch and rules for proportioning a modern hydraulic ram, such, for instance, as the "Galiban" ram? I have studied the description of the hydraulic ram given in Rankine's "Prime Movers," but the sketch there given is very obscure, and I cannot follow the action of the waste water valve.—Querist.

TO CORRESPONDENTS.

Student.—The horse-power of an engine is found by dividing the total foot-pounds of work performed by the engine per minute by 33,000, which is taken to represent the work of one horse in a minute. Foot-pounds of work done by the engine is easily ascertained by multiplying the area of piston in square inches by the mean effective pressure per inch, and by the distance in feet passed through per minute. All these quantities can be filled in from the data given in your letter, with the exception of the mean effective pressure, which can only be ascertained from an indicator diagram.

Millwright.—We do not know of any book devoted specially to the information. Indeed, the matter is too simple to require more than a small section to explain thoroughly. Probably the book that would be of most service to you is the one on "Applied Mechanics," by Cryer and Jordon, advertised on the front page of this journal.

C. Robertson.—It is usual to make the distance between the points of attachment of the eccentric rods to the link about three to four times the traverse of the valve. In your case, you might say 18in. The length of the slot would of course be greater than this by the length of the block, plus a little allowance for clearance.

St. Luke.—The book is published by the Practical Publishing Company, New York. The price, we believe, is one dollar. You ought to be able to get it through any bookseller. Referring to the questions regarding rise of incline, the matter is too elementary for our space. Your best course would be to get some little book on trigonometry; "Walmsley's Elementary Trigonometry" would perhaps suit you as well as any.

Box.—Without exact details regarding the position of injector, it is difficult to advise you. Your best course would be to write to the makers.

MISCELLANEA.

Fatal Boiler Explosion at Usan.—On Tuesday afternoon a boiler explosion occurred at the farm of Scotton, at Usan, near Montrose. Several men were engaged at a threshing machine, when with a loud report the boiler of the engine exploded, killing three men on the spot and severely injuring several others.

Watkin's Range Finder.—The apparatus devised by Major Watkin, R.A., by means of which the exact position of a hostile vessel can be at once determined and the guns of a fort trained to fire upon it without the necessity of the gunners seeing the object aimed at, has proved so satisfactory and has been so much developed that the authorities have determined on its adoption with as little delay as possible in all the principal forts at home and at our coaling stations.

Regularity of Ocean Steaming.—An illustration of the closeness and regularity of the steaming qualities of modern ocean-going steamers has just been afforded in the last homeward voyage from New York to Southampton of the steamships Ems and Saale, of the North German Lloyds. The Ems left Sandy Hook on Tuesday, the 16th ult., at 4 p.m., followed by the Saale on Wednesday, the 17th, at 5 p.m. The Ems passed Hurst Castle on Wednesday, the 24th, at 7-20 p.m., and the Saale passed the same station on Thursday, the 25th, at 7-30 p.m. There was thus only a difference of 50 minutes in a steaming run of 3,150 miles.

Survey of the White Sea.—The hydrographers charged with an exhaustive inquiry into the depth and navigability in other respects of the White Sea recently returned to Archangel. They began their investigations at the end of May, in the Bay of Onega. One party of three officers made a special examination of the Gulf of Soroki. One discovery was that of a bank 11ft. below water line, where a depth of 35ft. was marked. As there is a project mooted for a canal from Onega to the White Sea, it is observed by the explorers that a good port at Soroki is essential. Several deviations were also noted in the channels of the rivers Corelia and Dwina. The former will soon be dried up, while the latter promises to improve. A lighthouse is pronounced necessary on the island of Kü, and another is scarcely less needed at Cape Zetny Orlow. The reefs off Moutssalma Island are also badly indicated, and the lighthouse at Orlow would be useful as indicating their precise situation. In support of these improvements the fact is put forward that Russian ships are wrecked by hundreds in the Arctic seas.

Derby Society of Engineers.—The fifth session of this Society opened in an auspicious manner last week, when a large number of members met together in the Mechanics' Institute, Derby, to hear a paper on "The Graphophone" by Mr. W. L. Preece. The president, Mr. H. Swingler, took the chair. The author, in the course of an excellent paper, described Tainter's ingenious invention, which is now creating such a sensation in the scientific world. He clearly showed the manner in which the sound waves acted upon a diaphragm of mica, and were recorded and retained for an indefinite period on a cardboard cylinder, having on its surface a thin layer of wax; and how, at the pleasure of the operator, the sounds could be reproduced and repeated any number of times. The lecture was made much more interesting by seeing a machine at work, which had been kindly lent for the occasion. At the close of the meeting cordial votes of thanks to the chairman and lecturer were heartily carried. We are always glad to find engineering societies flourishing in our provincial towns, and in an engineering centre like Derby there is considerable scope for one to make a name of some standing, and we wish every success to that which has for the last four years been so prosperous under the honorary secretaryship of Mr. W. Gadsby Peet.

Destruction of the Yellow River Embankment.—It is reported from China that the whole of the new embankment of the Yellow River, which was commenced last autumn at the spot where the old embankment gave way, has been completely swept away by the summer floods. It is said to have cost about £200,000 (9,000,000 of taels). As the floods rose, it was seen that the strain was becoming dangerous, and Li Hang-tsao, the high official in charge of the work, was sent for in hot haste, but before he could arrive the whole bank went down before the flood, and of the 8,000ft. of river wall lately completed not an inch remains, and the waters are pouring unchecked through the immense gap into the Honan province. From 800 to 1,000 labourers who were on the bank were also swept away and drowned. It is reported from Pekin that all the officials concerned are being severely punished. Li Haug-tsao and the governor of the province are being dismissed and degraded; another high official is being banished to Mongolio, and the late High Commissioner of the Yellow River is to be banished to the Amoor. The disasters can scarcely stop as they are now, because the volume of silt-laden waters will create shallows which will still further increase the inundated area, and may cause an overflow into the Yangtse, which will make the conservation of that great waterway a matter of urgent importance.

The Coral Industry.—The French Consul at Leghorn, in a recent report, states that the coral industry, which has long flourished in Italy, has in recent years been declining. The price, which in 1883 was 800f. per kilogramme for wrought coral, fell to 600f. in 1884, 400f. in 1885, and was down to 200f. in 1886 and 1887. The export from Leghorn, which was valued at 11,298,400f. in 1883, amounted only to 3,104,600f. in 1886, while in quantity the exports increased in these years by 10 per cent. The great fall in price, which is ruining the industry in Leghorn, is attributed to the large supplies which come from Sciacca, in Sicily. It is believed these are due to some kind of submarine disturbance having put the coral where it is now obtained. Raw coral of medium quality has fallen in price from 10f. per kilogramme to 3f., and even less. The greater part of the coral manufactured in Leghorn is sent to Russian Poland, Finland, Russia, the Balkan Peninsula, Asia, and Africa. From the most ancient times every country has had its favourite shapes. In spite of the universal fall in prices, the best worked coral is still dear. A perfect piece of dark colour, about the size of a pigeon's egg, is still worth 800f. to 1,000f.; ten years ago, it would have cost 1,600f. to 1,800f. The red, whitish, and generally the light colours are less prized than the dark ones. Many houses in Leghorn in the trade are already shut up. Ten thousand women were formerly employed in the industry; the number now is about half of this. Yet nearly double the quantity is now exported than in 1882, but it is of inferior quality and receives less handwork. No machines are used, nor are there any mechanical processes in connection with the manufacture. The women give the required forms to the pieces by hand. The women get 7d. to 15d. per day. In Europe coral is in little demand, but it seems to have a special suitability for barbarous and semi-civilised peoples.

SELECTED PATENTS.

APPLICATIONS FOR LETTERS PATENT.

October 19th.

15023 Regulating Hydraulic Machinery, J. Fraser, Highbury, N.
15030 Steam Engines, J. Gwynne and C. F. Cooper, London.
15034 Clutches, G. H. Holden and J. Ashworth, Manchester.
15038 Hose Pipe, J. C. Merryweather, Kent.
15046 Pumps, &c., P. C. Rousseau, London.
15060 Machine for Compressing Air, &c., F. F. Clarke, Walsall. (E. F. Clarke, New Zealand.)

October 20th.

15071 Gas Engines, J. Imison and W. Tonkinson, Sunderland.
15072 Safe Working of Steam Engines, T. Wood and J. Lowcock, Burnley.—[Complete Specification.]
15074 Pulleys, A. Ashmore, Birmingham.
15077 Fastenings for Carriage Windows, M. H. Wells, Manchester.
15079 Weighing Machines, J. Greenwood and T. Greenwood, Manchester.
15082 Sight-feed Lubricator, G. M. Marchant, Huddersfield.
15083 Oil Feeders, G. W. Pridmore and S. Snell, Birmingham.
15085 Tools, &c., J. Willis, of J. Willis and Co., Sheffield
15086 Splicing Machine Belts, W. Johnstone, Edinburgh.
15088 Auxiliary Feed-water, D. B. Morison, Hartlepool.
15092 Pedal or Foot Motor, Y. Hameury, London.
15096 Lubricators, W. P. Thompson, Liverpool. (C. H. Parshall, sen., United States.)
15099 Fence Making Machine, T. H. Heberling, London.—[Complete Specification.]
15101 Dry Concentrators, C. N. B. Wetzlar, London. (W. L. Card, United States.)
15102 Hoisting Machinery, A. L. Fyfe, Middlesex.
15109 Water-wheel, A. Sautter, London.
15110 Steel and Iron Pipes, S. S. Lloyd and J. H. Lloyd, Middlesex.
15113 Revolving Shafts, J. Lang and P. S. Grant, Glasgow.
15117 Gas Motor Engines, F. W. Crossley and F. H. Anderson, London.
15119 Clutches, C. L. Hart, London.
15125 Governing Steam Engines, J. Higginson, jun., London.

October 22nd.

15134 Cutting Key-ways, J. Dickinson, Bradford.
15137 Refrigatory Appliances, G. Collier, Somersetshire.
15138 Purification of Water, G. Collier, Somersetshire.
15152 Brick Machines, J. Denham, Stockport.
15153 Working Hot Blast Stoves, H. le N. Foster and W. Coultas, London.
15158 Hydro-carbon Engines, G. M. Richards, London.
15165 Safety Devices, D. Smith, Middlesex.
15167 Draught in Steam Boiler, F. W. Flinn, Liverpool. (Communicated from abroad.)
15172 Copper Amalgamating Plates, R. J. Atcherley and A. E. Sarti, London
15180 Stay Bolts, A. F. Yarrow, London.—[Complete Specification.]

October 23rd.

15199 Curved Tubes, B. E. Hipkins and D. Strapp, Ramsgate.
15210 Hoisting Machinery, W. Walker, Smethwick, and C. A. Marriott, Handsworth.
15217 Lubricating Apparatus, St. J. V. Day, Glasgow. (H. O'Connell and S. A. Cahill, United States.)
15218 Driving Belts, J. Fenton, Glasgow.
15226 Steam Boilers, D. R. Todd, London.
15235 Sheet-metal Lathing, G. Hayes, London.—[Complete Specification.]
15236 Cementing Asbestos, J. Dewrance and B. E. Church, Lambeth.
15239 Intercepting Valves. H. L. Lange, London.
15241 Brakes, the Surrey Machinists' Company (Limited), and G. J. Stevens, London
15244 Gas Engines, W. P. Thompson, Liverpool. (H. C. Covert, United States.)
15245 Attachment for Lathes, W. H. Price, Liverpool.
15246 Ventilators, W. P. Thompson, Liverpool. (G. A. Pritchard and E. Mignault, United States.)
15264 Air Compressors, W. D. Bohm, London.
15265 File Holders, W. L. Wise, London. (C. Larne, Brussels.)

October 24th.

15280 Distribution of Motive Fluids, J. Fröhlich, London.
15284 Water Gauges, J. King, Glasgow.
15290 Ladles, W. Ambler, J. Rhodes, and S. Rhodes, Bradford.
15292 Gas or Oil Engines, A. Shirlaw, Birmingham.
15293 Acetate or Pyrolionite of Iron, P. McLaren, Glasgow.
15294 Regulating Gas Tap, R. L. Baker, Manchester.
15298 Feed Water Heaters, W. H. Rushforth, London.—[Complete Specification.]
15305 Valve or Tap, O. Rose, London.
15309 Fog Signalling, H. Page, London.
15310 Taps, E. Reynolds, Sheffield.
15311 Turning Ingots, A. Seddon, Sheffield.
15313 Cranked Shafts, W. A. Young, Glasgow.
15314 Friction Clutches, S. Ford, London.
15322 Coupling, M. Immisch, London.
15323 Hoists, B. J. B. Mills, Middlesex. (P. Cortassa and S. Mandrile, Italy.)
15328 Chaff Cutters, J. W. Throop, London. (H. H. Kendrick, United States.)
15329 Steam and Air Engines, A. Fehlen, London.
15330 Filtration of Water, G. D. Gerson, London.
15332 Fire Escapes, H. Orme, Middlesex.
15338 Coupled Locomotive Engines, H. Livesey, of the firm of J. Livesey and Son, and H. L. Lange, London.

October 25th.

15342 Apparatus for Transhipping Coal, D. B. Morison, Hartlepool.
15343 Steam Generators, W. Schmidt, Berlin.
15345 Fireplace of Steam Boiler, G. Holding, Bradford.
15354 Belts, Bands, &c., T. Hill, Fifeshire.
15361 Rotary Engines, A. N. Porteous, Edinburgh.
15370 Screw Taps, &c., F. J. Hadfield, London.
15371 Bib Taps, &c., J. B. Smith, London,
15380 Tools, W. H. Rickard and T. J. Rickard, London.
15389 Machinery, A. Winrow, London.

PUBLISHERS' ANNOUNCEMENTS.

BACK NUMBERS of "The Practical Engineer," from the commencement, can be obtained at either of our offices in London or Manchester, or by order of any Newsagent.

Vol. I. (bound), containing Nos. 1 to 44 inclusive, from March to December, 1887, price 6s. 6d., can still be obtained by order from any Newsagent, or will be forwarded, carriage paid, from either of our offices on receipt of the amount by postal order or stamps.

Numerous complaints having been made to us by Subscribers of the difficulty they experience in obtaining copies of the *Practical Engineer* in certain districts, we have to state that the Journal can be obtained by any Newsagent through the ordinary trade channels, and no difficulty should therefore exist in obtaining copies *by order* of any Newsagent.

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EDITORIAL NOTICES.

All communications for the Editor of this Journal should be addressed to 6, Victoria Station Approach, Manchester.

Communications intended for insertion in the current week's issue should reach us not later than Tuesday Evening.

We cannot undertake to return rejected manuscripts or drawings unless accompanied by a stamped and directed envelope.

Contributors are requested to write on one side only of the paper. Sketches should be sent on separate sheets.

TO ADVERTISERS.

Advertisements intended for insertion in the current issue should reach us on Wednesday morning at the latest.

THE
PRACTICAL ENGINEER.

NOVEMBER 9TH, 1888.

TO OUR READERS.

As our readers will be aware, *The Practical Engineer* is now rapidly approaching the end of its second volume, and in a few weeks it will have been before the public for a period of two years. At the time the journal was first launched it was felt in many quarters that the science of engineering had grown so comprehensive, and embraced so wide a field, that it was impossible for any single organ to deal adequately with the requirements of every branch of the profession, and that the attempt of some of our contemporaries to do this resulted in many sections of engineering receiving very imperfect treatment. These remarks it was thought applied with special force to that portion of the profession which may be perhaps broadly indicated by the term heat or motive engineering, and its collateral branches. It was further felt that such treatment as this branch did receive was often so theoretical and recondite as to be far beyond the comprehension of the average reader, while it was largely wanting in that practical element which plays so large a part in the science of engineering construction.

It was with a view to remedy this defect, and to supply first-class original matter which should be of interest and value to employers and foremen, while it was at the same time issued at such a price as to be within the reach of the intelligent artisan, that this journal was first inaugurated. That the views held by its promoters were well founded has been fully demonstrated by the avidity with which *The Practical Engineer* has been accepted in those circles dealing with the subjects with which it is specially identified, and whose interests it endeavours to watch and guard. The large and world-wide circulation which the journal has attained during the comparatively short period of its existence, together with the numerous complimentary letters we are continually receiving both from readers and advertisers, bear gratifying testimony to the esteem in which it is held and the value which is placed upon its opinions.

The only complaint we have received—and this may be considered rather complimentary than otherwise—has been that the journal was not large enough, and that its contents were too quickly got through. We must confess that we have felt that there was considerable force in this objection, while the difficulties of the present limited space at our disposal have been impressed upon us in other ways. We have very often had more matter than we could dispose of, and in some cases have been reluctantly compelled to compress that which we should have preferred to give *in extenso*, while in others we have, from lack of room, been forced to exclude the information altogether. There is manifestly a limit to the space available in a journal issued at the nominal price of one penny, and the fetters which these limits have imposed upon us have become more and more irksome with lapse of time. Even with the limited range of subjects to which we devote our attention, the choice of articles from the matter available, in order that the journal might be fairly representative, has frequently taxed our ingenuity, while our readers will scarcely need to be told that at its present price it is impossible to enlarge the journal. We believe, in fact, that there is no precedent, either in this or any other country, for the attempt to produce a purely technical journal, *consisting largely of original articles*, contributed by eminent members of the profession, at the price at which *The Practical Engineer* has been issued.

It has now, therefore, become a matter for serious consideration whether to continue the journal in its present form, or to increase its size and thereby enhance its usefulness and efficiency. After making full inquiries, and after discussing the matter in all its bearings, we have come to the conclusion that we shall best meet the wishes of the great bulk of our readers by enlarging the size of our journal. This alteration it has been decided to effect by increasing the number of pages rather than their present dimensions, so that the new series will be continuous with the old as far as the binding is concerned.

In addition to the increase in the size of the journal, it has also been decided to improve its appearance by printing it on a superior paper and enclosing it in a neat tinted cover. To meet these alterations and improvements it will be necessary to increase the price from one penny to twopence, a sum which we think our readers will agree with us is still but nominal.

We purpose to effect this alteration in our issue for the 23rd of the present month, but before doing so thought it but fair that we should take the whole of our readers into our confidence, so that the change might not come upon them by surprise, and in order that they might know the reasons which had influenced us in our decision. We have little doubt that the contemplated change will meet with general approval, and our friends may rest assured that no pains or expense will be spared to sustain the reputation the journal has already acquired as the organ of steam engineering. The success already achieved will be but an incentive to further exertions, while we regard our present gratifying position as but an earnest of that which awaits us in the future.

NATIONAL DEFENCE.

The shafts of public opinion appear at last to have penetrated the veil of exclusiveness and red tapeism in which our great Government spending departments have hitherto enshrouded themselves, and to have aroused the presiding authorities both at the War Office and at the Admiralty to a due sense of their responsibilities. The tin bayonets, defective cartridges, and other gross scandals brought to light in connection with the recent Egyptian campaign will be fresh in the public memory, and we are glad to learn from a speech made by the Secretary of State for War, a few days ago, at the Islington Hall, that the defective supervision which permitted such irregularities to exist has been reformed, and that in future the method of testing and inspection will render it impossible for defective arms or accoutrements to pass into the public service. Fighting is certainly a dreadful way of settling differences between nations, but so long as the world is constituted as it is, we fear the arbitrament of force will occasionally be resorted to; and such being the case, it is essential that the weapons in the hands of our defenders should be of the highest excellence. War is a game of sharp cuts and hard knocks, and the highest courage is of little avail, unless well armed. We are glad to learn from Mr. Stanhope, therefore, that after a series of exhaustive trials under various conditions of climate, &c., the new magazine rifle has proved itself admirably adapted for its purpose, and that our troops, when supplied with it, will be equipped with "the best rifle in existence."

GROWTH OF MIDDLESBROUGH.

Some interesting facts illustrating the rapidity with which the growth of industrial centres is sometimes effected were given in connection with the recent opening of the new breakwater for the river Tees. The development of the river has been a necessity due to the rapid rise of Middlesbrough.

So recently as 1831 the total number of inhabitants of the district now covered by Middlesbrough was only 154, while a few years earlier there is said to have been but a solitary farmhouse standing on the spot now occupied by one of the most important manufacturing towns in the kingdom. In 1829 an estate of some 500 acres was purchased under the name of the Middlesbrough Owners as a site for a new town. In the following year the Stockton and Darlington Railway was extended to the spot, and a large business in the shipment of coal was begun.

Subsequently a pottery, a shipyard, an engine works, and extensive brickyards were established. Ten years later, Messrs. Bolckow, Vaughan, and Co. established ironworks on ground which was covered to a large extent by the Tees at high water. For a few years the operations were confined to the manufacture of finished iron, the supply of material for which was to a very large extent imported. The rich mineral treasure lying close at hand, hidden in the Cleveland hills, had not been found, and their existence was not even dreamt of. Ten years later, the discovery of a seam of ironstone near Redcar, by Mr. J. Vaughan, led to the rapid enlargement of Messrs. Bolckow and Vaughan's works, and secured for Cleveland iron a world-wide reputation. In the course of a dozen years the undertaking of these two men assumed gigantic proportions, and then the works were converted into a limited company, with a capital of two and a half millions.

The example of these pioneers was rapidly followed, with the result that there are now in the north of England 155 blast furnaces, producing upwards of 220,000 tons of pig iron per month. The rail mills, shipbuilding yards, steelworks, and engineering establishments rapidly grew and flourished, while to these industries a large salt and chemical trade has since been added.

The manner in which the salt beds were discovered shows out of what slight accidents large manufacturing industries frequently take their rise. In 1864 Messrs. Bolckow, Vaughan, and Company, while boring for water, came upon a deposit of rock salt. A shaft was afterwards sunk, but in consequence of difficulties arising from the large quantity of water encountered, sinking was for a time abandoned. In 1874 Messrs. Bell Brothers, ironmasters on the north side of the Tees, put down a bore-hole in their works, and at a depth of 1,100 feet brought up cores containing quantities of salt. Shortly afterwards they pumped up brine, and after that put up a number of evaporating pans, and added a large chemical factory to their iron industry. The successful efforts of these gentlemen induced several others to follow their example, the result being that the total output of salt exceeds 3,000 tons per week.

Under the control of the Tees Conservancy Commissioners the navigation of the river Tees has been greatly improved to meet the growing requirements of the various trades. On its banks miles of training walls and great breakwaters have been constructed out of the millions of tons of slag and other waste products from the blast furnaces, so that a wide estuary between Redcar and Seaton has been converted into a harbour of refuge. Vessels from all parts of the world now come to Middlesbrough, and the population, which in 1831 was only 154, has now grown to upwards of 75,000, and furnishes indications that it is still far from having attained its maturity.

PRACTICAL NOTES ON MARINE ENGINEERING.—XVII.

(*Continued from page* 508.)

Screw Propellers.

So far we have been referring principally to single screws, but where twin screws are adopted the diameters are much less for the same power, and in some instances the combined area of the two screws has been considerably less than what would have been required for a single screw. Generally speaking, the area of the two screws may be made equal to the single screw. Thus, to maintain the same area,

$$D = \frac{\sqrt{\tfrac{1}{2}\,\text{I.H.P.}}}{\sqrt[3]{\dfrac{s}{c}}} = \text{diameter of each screw,}$$

where I.H.P. = the total indicated power of both engines.

There are examples to be found among twin screws where the total area of propellers is less than half that for a single screw of the same power.

Thus for half the total area—

$$D = \frac{\tfrac{1}{2}\sqrt{\text{I.H.P.}}}{\sqrt[3]{\dfrac{s}{c}}} \text{ or } D = \frac{\sqrt{\tfrac{1}{4}\,\text{I.H.P.}}}{\sqrt[3]{\dfrac{s}{c}}}$$

where I.H.P. = total power of both engines.

Written in the latter form it is easier to refer to the table, as $\frac{1}{4}$ I.H.P. will come within the limit of powers given.

Examples : One screw 1,000 I.H.P. at 10 knots.

$$D = \frac{\sqrt{\text{I.H.P.}}}{\sqrt[3]{\dfrac{s}{c}}} = \frac{31{\cdot}6}{3} = 10{\cdot}5 \text{ diameter} = \text{about } 86{\cdot}5 \text{ area.}$$

For twin screws, 1,000 I.H.P. or 500 for each engine at 10 knots.

$$D = \frac{\sqrt{\frac{1}{2}\ \text{I.H.P.}}}{\sqrt[3]{\frac{s}{c}}} = \frac{22{\cdot}3}{3} = 7{\cdot}4 \text{ diameter} = \text{about } 43 \text{ area each.}$$

For twin screws with half total area.

$$D = \frac{\frac{1}{2}\sqrt{\text{I.H.P.}}}{\sqrt[3]{\frac{s}{c}}} = \frac{15{\cdot}8}{3} = 5{\cdot}26 \text{ diameter} = \text{about } 21{\cdot}7 \text{ area each.}$$

2. Pitch is proportional to the speed, and inversely proportional to the revolutions per minute. Speed of vessel being fixed, we have

$$\frac{\text{Speed in knots} \times 6{,}080}{\text{revolutions per minute} \times 60} = \text{pitch without slip,}$$

that is, the speed which would be attained supposing the vessel to be propelled in exact proportion corresponding to the angle of the blades; but as this is not true in the majority of cases it is usual to allow for the probable difference between the speed of vessel and that due to the screw. From 5 to 15 per cent may be allowed according to circumstances.

The diameter and pitch being fixed, the slip increases as the length of blade decreases, and the smaller the ratio of pitch to diameter the less is the slip for any given length.

When the length of boss is kept small, say to allow of the propeller being removed without drawing the shaft, an extra allowance for slip may be made.

If the slip is stated in terms of speed of vessel, the pitch will be

$$P = \frac{S + \frac{s \times \%}{100}}{\text{Rev.} \times 60}$$

where S = speed of ship in feet per hour—that is knots × 6080.
„ % = per centage of slip allowed—average about 10; or approximately

$$P = \frac{100\,S + \frac{s \times \%}{100}}{\text{Revolutions.}}$$

This may be considered near enough for all practical purposes,
where P = pitch, in feet.
S = speed of vessel in knots per hour.
Rev = revolutions of engine per min.

When the slip is stated in terms per cent of pitch,

$$\frac{100\,(s - S)}{s} = \text{slip}$$

where s = speed per min. due to screw = rev. × pitch,
„ S = speed of vessel in the same time.

The revolutions here enter into the calculation, and some idea should therefore be formed of the probable number the engine will run. There are so many matters of arrangement and detail which determine this, that it is difficult to formulate an expression to suit all conditions. The boiler pressure and consequent pressure referred to the low-pressure cylinder is an important factor. The length of stroke in proportion to the diameter of cylinder is another, and the relation between the power of engine and rapidity of ship is another, and may limit the revolutions on account of excessive vibration. Supposing, however, that everything is within ordinary limits, the revolutions may be said to vary as the square root of the low-pressure cylinder, and inversely as the stroke of the piston. They may also increase as the cube root of the power. Then in these ratios,

$$\text{Rev. may equal } \frac{100\sqrt{\frac{1}{2}\,D}}{4\,s} \times \sqrt[3]{\frac{s}{c}}$$

Where s = stroke in feet.
„ D = diameter of L. P. cylinder and $\sqrt[3]{\frac{s}{c}}$ as before.

Thus, for a 72in. cylinder, with a stroke of 5ft., to drive a vessel at 10 knots, the revolutions will be

$$\frac{100\sqrt{70}}{4 \times 5} \times \sqrt[3]{\frac{s}{c}} = 70,$$

and to drive at 16 knots would be 90 per minute.

Again, a 30in. cylinder, with a stroke of 21in., to drive 10 knots would run about 166, and for 20 knots 242 per minute.

3. The surface: This is the area of blades acting on the water to overcome the resistance of the vessel, and is proportional to the area of propeller, and inversely proportional to the speed, and may be from

$$\frac{D^2}{4{\cdot}3} \text{ for 9 knots to } \frac{D^2}{2{\cdot}9} \text{ for 21 knots}$$

where D = diameter of propeller.

In these proportions for high speeds three blades would be more suitable than four.

Independent of the actual surface required to drive the vessel in smooth water, there is a fair amount required to keep her up to head wind and sea. That is, a very efficient propeller could be designed for speed alone in smooth water, but which might be of no use on a round voyage. On the other hand, the best screw for a round voyage might fall off in efficiency when on a speed trial.

(To be continued.)

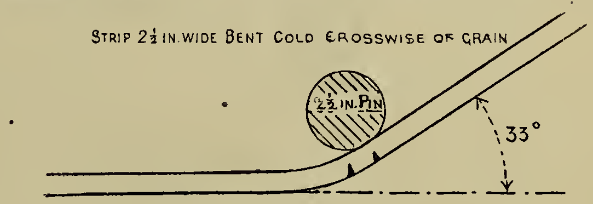
THE BIRMINGHAM EXPLOSION.

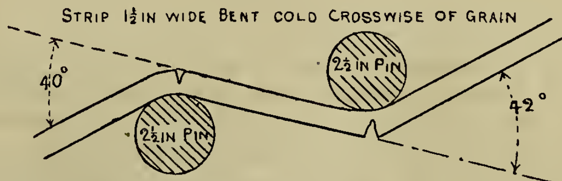
We stated in our issue of the 26th ult. that there were several points in connection with this explosion which called for comment, and it was our intention to have dealt with the matter last week, but pressure upon our space has compelled us to hold over our remarks to the current issue.

It will be remembered that the verdict returned by the coroner's jury was one of "accidental death," and although we do not look upon such verdicts regarding boiler explosions with a particularly friendly eye, yet we feel constrained to admit that we do not see what other verdict, having regard to the facts of the case, could have been delivered. We consider it necessary to premise this in order that due credit may be accorded to the remarks which follow.

As we have already pointed out, there can be little doubt the flaw from which the explosion sprung was started in the first instance when the boiler was in process of construction, and an inspection of the results of tests that have since been conducted to ascertain the quality of the material of which the boiler was made renders it easy to understand why the flaw should have been started in the first instance.

Two test strips, cut in the direction of the grain, and each 2½in. wide, on being pulled asunder only afforded a tenacity of 14·6 tons and 17·15 tons respectively, while another pair, cut crosswise, only gave a tenacity of 19·09 tons and 18·5 tons. It was however, in respect to their ductility that the inferior quality of the iron was most marked. The extension in a length of 10in. in the strips cut lengthwise was only 1·25 per cent in the first case, and 2·5 per cent in the second, while in the strips cut across the grain the extension was only 1·25 per cent and 1·87 per cent respectively. When it is remembered that similar strips of good iron plates usually afford an ultimate tenacity of upwards of 20 tons per square inch, with an extension varying from 7 to 10 per cent, it will be evident that the plates of which the boiler was made were lacking in ductility, and ill qualified in the first instance to stand the working in the rolls necessary to bend them into the circular form. Their brittle character was indeed made even more strikingly manifest when an attempt was made to bend some of the test strips round a fixed pin, the slightest departure from a straight line, as will be seen on reference to the accompanying sketches, causing the strips in one or two cases to fracture on the outside, repeating, in fact, in a slightly aggravated form, the destructive operation which was effected on the plate when the boiler was made.

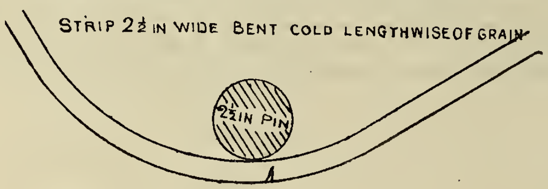


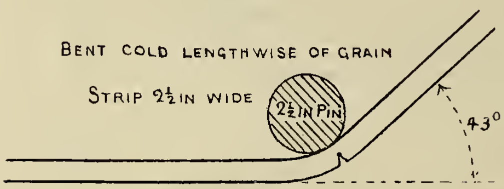


Looking at the brittle quality of the plates, as indicated by the tests, there can be no doubt that when passed through the bending rolls in the first instance they would be very severely tried, and it is easy to see that the punishment inflicted would be most severe in the line of the longitudinal seam, where the plate had been already weakened by the *punching* of the row of rivet holes. The savage treatment which the ends of plates occasionally receive in order to impart the requisite set at the joint, coupled with the use of the drift, might possibly in this case have had something further to do with the starting of the fracture. Indeed, the matter for surprise to us, having regard to the quality of the material, is not that an incipient flaw was started when the boiler was made, but that it should have taken so long to develop into an actual rupture.

As the question will doubtless be asked by many boiler owners whether something could not have been done before the explosion to ascertain the quality of the plates, or whether the ordinary resources of boiler inspection are powerless to discover the presence of such defects as those which existed in this case, and as an attempt may possibly be made in some quarters to suggest that the insurance company with which the boiler was enrolled was in some way responsible for the disaster, it is desirable, both in the interests of boiler insurance companies and of the public generally, that we should devote a few words to this aspect of the case.

To engineers the suggestion that the quality of a plate might be ascertained by a mere examination of its external surface will appear almost too ridiculous to be worthy of comment. We should not have referred to it did we not know from actual experience that many steam users regard a boiler inspector as a being who possesses, or ought to possess, supernatural and omniscient powers. We therefore beg to point out for the benefit of such persons, that although a boiler inspector does frequently discover defects which, considering the difficulties under which he labours, might very well escape detection and afford considerable justification for the belief referred to, yet he is but human, and can see no further through a half-inch boiler plate than an ordinary mortal. The only way such a defect could have been discovered by inspection, in the absence of its affording the slightest indication of its existence, would have been by pulling the boiler to pieces, and the adoption even of such a course would have been no guarantee against the existence of other similar defects when it was riveted together again.





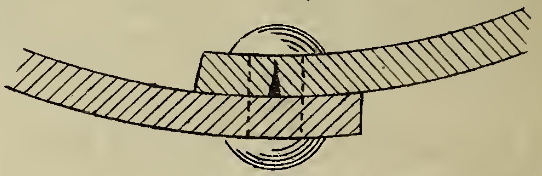
Messrs. Watson and Todd, the owners, as well as the Boiler Insurance and Steam Power Company of Manchester, with whom the boiler was insured, and who periodically inspected it from time to time, appear to have exercised every care and caution which experience could suggest, and cannot, to our minds, be held responsible for the disaster, even in the slightest degree.

The blame, if any is to be allotted for the explosion, must be laid on those who made the boiler in the first instance, and, in apportioning it, regard should be paid to the fact that it was a dozen years old, and the science of boiler construction was by no means so exact or so widely understood then as now.

Great value is attached in some quarters to the application of the hydraulic test, and as it may possibly be urged that its adoption in this case would have brought the flaw to light, it may be well if we consider for a moment this view of the case. We must confess at the outset that we do not entertain that great veneration for the hydraulic test which is held by some engineers. Although the test is doubtless of value in certain cases, as affording a means of ascertaining the strength of unstayed surfaces of undeterminate shape, or as affording an indication of the strength of structures which are inaccessible, yet it is a poor substitute for reliable inspection, and for our own part we should prefer careful examination without the hydraulic test, to the hydraulic test without such examination. The indiscriminate application of the hydraulic test to boilers that have been at work for a length of time may be productive of more harm than good, and it should certainly not be adopted unless there are strong grounds for believing that it would afford information which could not be obtained by ordinary inspection.

In the case of the boiler at Birmingham, the flaw, as we have already said, afforded no evidence of its existence. When first created, it would doubtless be very small, and the racking stresses to which all boilers are subject when in work gradually extended its dimensions until it became at length a serious source of danger. To discover such a defect, the hydraulic test would have afforded no assistance, unless it had been applied periodically, and at short intervals, and it is quite conceivable that resort to such a course might only have resulted in accelerating the growth of the defect, and precipitating the disaster a few years earlier. It will be seen, therefore, that, short of actual inspection of every plate and rivet hole during the process of construction, every possible precaution was exercised; and with regard to the importance of careful supervision during this portion of a boiler's history, we propose to say something further on a future occasion.

This is not the first boiler explosion that has arisen from the existence of a concealed flaw at a seam of rivets which the most careful inspection would fail to detect. A case very similar to the present one occurred at Grays, in Essex, on November 18th, 1887, and the facts are set forth in the Board of Trade Report of No. 265 Preliminary Inquiry. The boiler was comparatively new, and the explosion took place within seven months of its being set to work. Another occurred on November 23rd, 1883, at a saw mill at Bristol, and particulars will be found in the report of No. 60 Preliminary Inquiry. In each of these three cases it is interesting to note that the flaw from which the explosion sprung occurred at the inner overlap of a longitudinal seam, and started from the centre of the joint, so that it was entirely hidden from view. Happily explosions of this kind are extremely rare, and the three referred to are the only ones of this pronounced kind which we remember to have occurred during the last dozen years. We feel it necessary to state this fact to allay the tendency to panic which such a disaster is apt to produce, and in order that the magnitude of the danger may be correctly gauged.


Sketch showing position of Concealed Flaw.

The main lesson, to our minds, which appears to be taught by the explosion is the importance in the construction of steam boilers of using not only the best of materials, but also the best of workmanship. This, however, we are sorry to say, is not so generally realised by steam users as could be wished, and the merits of a boiler are too often measured, in the first instance, by a reference to pounds, shillings, and pence, without due regard to the quality of the material or the workmanship. We cannot, therefore, too strongly point out, in the interests of steam users themselves, that the cheapness of an article is not always to be measured by the cost price. It should be borne in mind that a modern steam boiler is a first-class piece of engineering, requiring in its construction the use of expensive tools and the exercise of considerable care, and the mauufacture of such vessels should not be entrusted to any who do not possess both the necessary tools and the requisite skill.

INSTITUTION OF CIVIL ENGINEERS.—There are now on the books of the institution 1,614 members, 2,499 associate members, 458 associates, 19 honorary members, and 939 students, together 5,529, being an increase at the rate of 3⅝ per cent during the past twelve months. The opening meeting of the session will be held on Nov. 13, when the medals, premiums, and prizes for the past session will be distributed by Sir George G. Bruce, the president, after which a paper will be read on "Friction Brake Dynamometers" by W. Worby Beaumont, M.Inst.C.E. At subsequent meetings, before Christmas, the following papers will be brought forward: "The Witham New Outfall Channel and Improvement Works," by J. Evelyn Williams, M.Inst.C.E., and "The Influence of Chemical Composition on the Strength of Bessemer Steel Tires," by J. Oliver Arnold, F.C.S.

THE ELECTRICAL TRANSMISSION OF POWER—III.

(Continued from page 526.)

THE next point to consider is the loss of power on the road between the dynamo at the one end and the motor at the other. It has been shown that since the power developed by the generator and motor depends on the product of the current into the electric pressure, while the loss when power is transmitted through a given wire depends on the square of the current and is independent of the electric pressure, the economical transmission of power by electricity on a large scale depends on the use of a very large electric pressure and a small current, just as the economic transmission of much power by water depends on the use of a very large water pressure and a small flow of water. At first it was not thought possible to construct a small dynamo to develop a very large electric pressure, or potential difference, as it is technically called, and therefore it was proposed to join up many dynamos in series at the one end, and many lamps or electro-motors in series at the other, and to transmit the power by a very small current which passed through all the dynamos and all the lamps in succession one after the other.

It is now possible, however, to use a very large potential difference between the main wires by means of which the electric power is economically conveyed a considerable distance, and transformed into a very small potential difference in the houses where it is utilised. An electric transformer is equivalent to a lever, or wheel and axle, or any other of the so-called mechanical powers. You know that a large weight moving through a small distance can raise a small weight through a large distance. There is no gain in the amount of work, but only a transformation of the way in which the work is done. A large weight moving through a small distance is analogous to a high potential difference and a small current, while a small weight moving through a large distance is analogous to a small potential difference and a large current, and an electric transformer is for the purpose of effecting the transformation with as little loss as possible, so that what is lost in potential difference may be all gained in current. Electrical transformation may be effected by (1) alternate current transformers, (2) motor-dynamos, (3) accumulators or secondary batteries, and (4) direct current transformers.

Of these apparatus the oldest by far is the alternate-current transformer, as it is merely the development of the classical apparatus invented by Faraday in 1831, and familiar to many of you as the Ruhmkorff or induction coil. A combination of a motor and dynamo was suggested by Gramme in 1874. Accumulators are the outcome of Planté's work, while direct current transformers are quite modern and not yet out of the experimental stage.

In America, alternate-current transformers are, thanks to the remarkable enterprise of Mr. Westinghouse, used to light 120,000 incandescent lamps in 68 towns; in fact, the electric lighting of a whole town from a central station begins to excite less astonishment than the electric lighting of a single house did ten years ago.

The efficiency of a well-made alternate-current transformer is very high, being no less than 96·2 per cent when the transformer is doing its full work, and 89·5 per cent when it is doing one-quarter of its full work, according to experiments made. It certainly does seem most remarkable, and it reflects the highest praise on the constructors of electrical machinery, that motor power can be converted into electrical power, electrical power at low pressure into electrical power at high pressure, or electrical power at high pressure into electrical power at low pressure, or, lastly, electrical power into motor power—in each case with an efficiency of 94 per cent.

Did time allow, I should like to describe to you to what perfection the system of economical distribution with accumulators—originally proposed by Sir William Thomson in 1881—has been brought; how the cells, when they are fully charged, are automatically disconnected from the charging circuit, and electrically connected with the discharging circuit; how the electric pressure on the discharging, or house mains, is automatically kept constant, so that the brightness of the lamps is unaffected by the number turned on; and how cells that are too energetic have their ardour automatically handicapped, and not allowed to give more current that is being supplied by the less active ones.

During the last few months fierce has been the battle raging among the electricians, the war cry being alternate-current transformers *versus* accumulators, while the lookers on, with that better view of the contest that they are proverbially said to possess, have decided that the battle is a drawn one. Neither system is the better under all circumstances. If the district to be lighted is a very scattered one, use alternate-current transformers by all means; but if the houses to be lighted are clustered together at a distance from the supply of power, then the storing property possessed by accumulators, which enables the power of electric power to far exceed the capacity of the dynamos and engines in the busiest part of the twenty-four hours, will win the battle for accumulators. Any direct-current system of distribution such as is furnished by accumulators has also the very great advantage that it lends itself to the use of efficient electro-motors. Alternate-current motors do exist, but they are still in the experimental stage, and are not yet articles of commerce.

Secondary batteries have caused much heartburning in their use from the apparent fickleness of their complex chemical action, yet but imperfectly understood. But we have at length been taught what is good and what is bad treatment for them, and after years of brave persevering application, that forlorn hope, the secondary battery, has become one of the most useful tools of the electrical engineer; and secondary cells may now be trusted to have a vigorous long life.

But of all the many commercial uses to which the electric current may be put, probably, after the electric light, electric traction has most public interest. The English are a commercial people, but they are also a humane people, and when, as in this case, their pockets and their feelings are alike touched, surely they will be radicals in welcoming electric traction, whatever may be their political sentiments on other burning topics of the day. It is not a nice thing to feel that you are helping to reduce the life of a pair of poor tramway horses to three or four years; it would be a very nice thing to be carried in a tramcar for even a less fare than at present. Now, while it costs 6d. or 7d. to run a car one mile with horses, it only costs 3d. or 4d. to propel it electrically. Indeed, from the very minute details that have recently been published of the four months' expenses of electrically propelling 30 cars at 7½ miles an hour along twelve miles of tramway line in Richmond, Virginia, it would appear that the total cost, inclusive of coal, oil, water, engineers, firemen, electricians, mechanics, dynamo and motor repairers, inspectors, linemen, cleaners, lighting, depreciation on engine, boiler, cars, dynamo and line work, has been only 1¼d. per car per mile. That is small enough at any rate; let us hope that it is true. This tramway is no doubt particularly favourable for propelling cars on the *parallel* system (that is, the system in which the current produced by the dynamo is the sum of the currents going through all the motors on the cars) without a great waste of power being produced by a very large current having to be sent a considerable distance, because the tramway track is curved, and the dynamo is placed at the centre of the curve, with feeding wires to convey the current from the dynamo to all parts of the track. But even in the case of a straight tramway line, with a dynamo only at one end, it is quite possible to obtain the same high economy in working by employing a large potential difference, and by sending a small current through all the trains in *series*, instead of running the train in *parallel*, as is done on the Portrush, Blackpool, Brighton, and Bessbrook tramways.

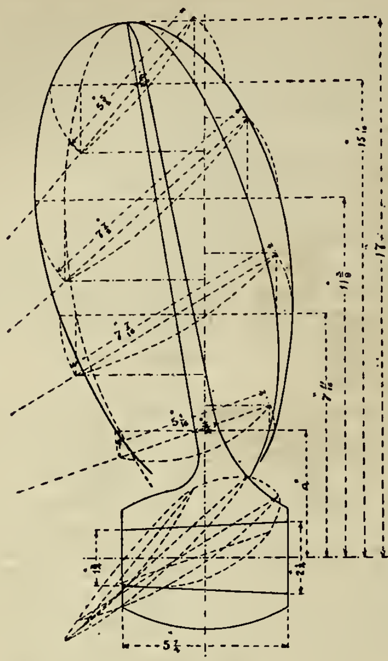
This *series* system of propelling electric trains was, oddly enough, entirely ignored in all the discussions that have taken place this year at the Institution of Civil Engineers, and at the Institution of Mechanical Engineers, regarding the relative cost of working tramways by horses, by a moving rope, and by electricity, and yet this series system is actually at work in America, and a series electric tramway twelve miles long, on which forty cars are to be run, is in course of construction in Columbus, Ohio. The first track on which electric trams were run in *series* was the experimental "Telpher Line" erected in Glynde in 1883, under the superintendence of the late Professor Fleeming Jenkin, Professor Perry, and myself, for the automatic electric transport of goods. The Series Electrical Traction Syndicate are now developing our idea, but it has received its greater development in the States, where the Americans are employing it instead of spending time in proving, *à priori*, that the automatic contact arrangements could never work.

In addition to the small waste of power, and consequent diminished cost of constructing the conductors that lead the current into and out of the passing trains, the series system has another very marked advantage. Some years ago we pointed out that when an electric train was running down hill, or when it was desirable to stop the train, there was no necessity to apply a brake and waste the energy of the moving train in friction, because the electric motor could, by turning a handle, be converted into a dynamo, and the train could be slowed or stopped by its energy being given up to all the other trains running on the same railway, so that the trains

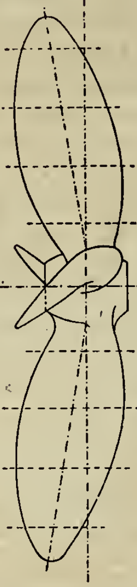
WORKING DRAWINGS.

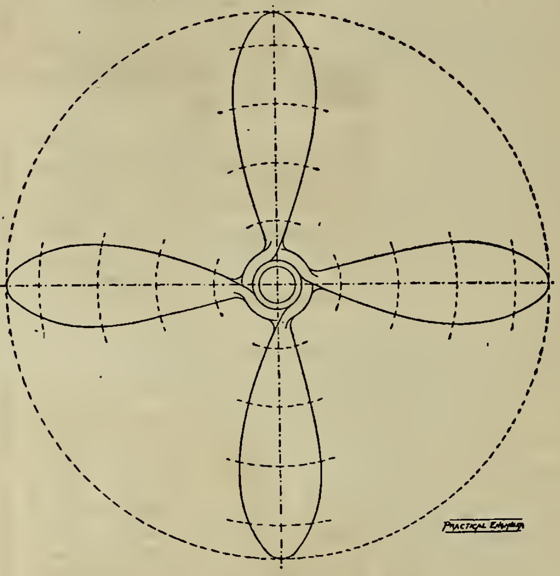
LAUNCH ENGINES VIII.—SCREW PROPELLER.

Uniform pitch of propeller 3ft. 4in.; Diameter of propeller 2ft. 10in.; Greatest length on line of keel 7½in.



Expanded View and Sections of Blades.





going down hill helped the trains going up hill, and the stopping trains helped the moving trains. At that time we suggested detailed methods for carrying out this economical mutual-aid arrangement, whether the trains were running on the parallel or on the series system. But there is this difference, that whereas on the parallel system it is only when a train is running fairly fast that it can help other trains, the series system has the advantage that, when a motor is temporarily converted into a dynamo by the reversal of the connections of its stationary magnet, the slowing train can hold all the other trains, even to the very last rotation of its wheels. Brakes that save the power instead of wasting it are of purely English extraction, but their conception has recently come across the Atlantic with such a strong Yankee accent, that it might pass for having been born and bred in the States.

Economy is one feature which gives electric traction that right to claim your attention; safety is another. The model telpher line, worked on "the post-head contact" system, is so arranged that no two trains ever run into one another, for in addition to each of the three trains being provided with an automatic governor which cuts off electric power from a train when that train is going too fast, the line is divided into five sections, connected together electrically in such a way that as long as a train is on any section A no power is provided to the section B behind, so that if a train comes into section B, it cannot move on as long as the train in front is on section A. Whenever a train—it may be even a runaway electric locomotive—enters a blocked section, it finds all motive power withdrawn from it quite independently of the action of signalmen, guard, or engine driver, even if either of the latter two men accompanied the train, which they do not in case of telpherage; no fog, no colour blindness, nor different codes of signals on different lines, nor mistakes arising from the exhausted nervous condition of overworked signalmen, can with our system produce a collision. Human fallibility, in fact, is eliminated. While the ordinary system of blocking means merely giving an order to stop, and whether this is understood or intelligently carried out is only settled by the happening or non-happening of a subsequent collision, our automatic block acts as if the steam were automatically cut off; nay, it does more than this, it acts as if the fires were put out in an ordinary locomotive, and all the coal taken away, since it is quite out of the power of the engine driver to restart the electric train until the one in front is at a safe distance ahead.

The Glynde line has recently been much extended in length by its owners, and a telpher line, with automatic blocking on the broad principles described, is about to be constructed between the East Pool tin mine in Cornwall and the stamps. There will be four trains running, each consisting of thirty-three skips, containing 3cwt. each, so that the load carried by each train will be about five tons.

It may be interesting to mention that the last difficulty in telpherage, which consisted in getting a proper adhesion between the driving wheels of the locomotive and the wire rope, has now been overcome. The history of telpher locomotives is the history of steam locomotives over again, except that we never tried to fit the electric locomotives with legs, as was proposed in the early days for steam locomotives. It is a tedious, discouraging history, but it is so easy to be wise when criticising the past, so difficult to be wise when prospecting the future. Gripping wheels of all kinds, even the indiarubber tires used for the last three years, have all been abandoned in favour of simple slightly loose cheap iron tires, which wear for a very long time, and give a very perfect grip when the bar supporting the electro-motor is so pivoted pendulum-wise to the framework of the locomotive that the weight of the motor no longer makes the locomotive jump in passing the posts, as it did until quite recently.

After several years of experimenting, we have in telpherage, I venture to think, at last a perfectly trustworthy and at the same time a most economical method of utilising distant steam or water power to automatically transport our goods, and in time it may even be our people, over hills and valleys without roads or bridges, and without interfering with the crops or the cattle, or the uses to which the land may be put over which the telpher trains pursue their snake-like way. We have, in fact, the luxury of ballooning without its dangers.

SCREW PROPELLER.

With the object of making the series of launch engine drawings, which have appeared in our columns from time to time, more complete, a set of drawings of the screw propeller is given.

The propeller has four blades of the pear-shaped pattern, with an inclination aft, which has been found to give good results on trial. The pitch is uniform. This screw propeller is an example of the cast-steel type now very generally adopted in small work of this class.

PORTABLE WINDING AND HAULING ENGINES.

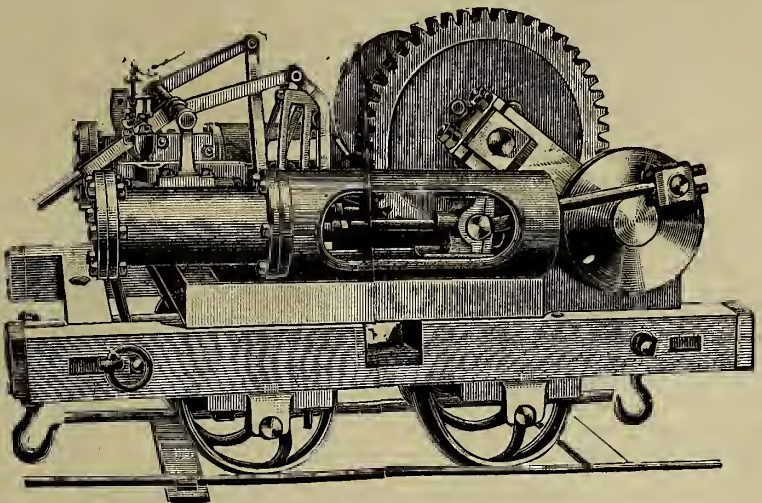


Fig. 1.

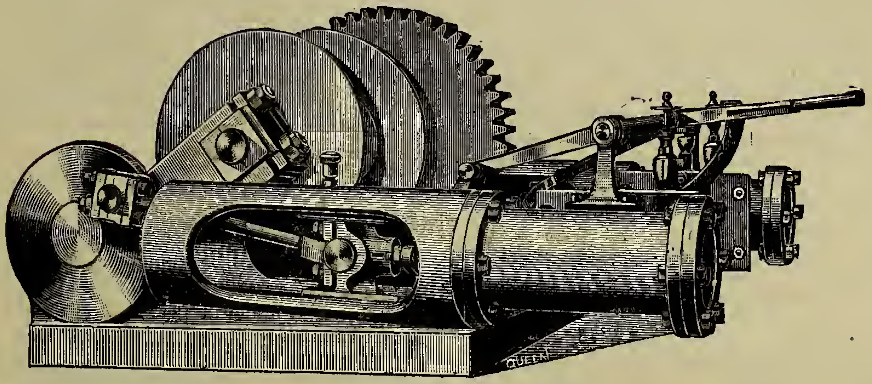


Fig. 2.

The question of underground haulage in mines is one of considerable importance, although hitherto it has scarcely received the attention it deserves. When underground winding has had to be done, it has generally been effected either by means of expensive fixed engines, similar to those above ground, or by the tractive force of horses.

The illustration given above represents a type of portable hauling engine made by Messrs. Wild and Co., of Chadderton, near Oldham, which has been designed to meet the special requirements of underground haulage, and which possesses several merits that recommend it for the object in view. One important requisite in engines of this class is that they should be compact, so as to be portable and occupy as little space as possible. Another is that they should be strong, so as to stand the rough usage to which all mining machinery is more or less subject, while the construction should be as simple as possible, in order that they may be worked by unskilled labour without fear of becoming deranged. The type of engine shown, which is the outcome of a considerable amount of practical experience on the part of Messrs. Wild with mining operations, appears to meet these requirements admirably. Fig. 1 represents a pair of engines with 4in. cylinders and 8in. stroke, mounted on a bogey for facility of transport. As the outside dimensions only measure 4ft. 6in. in length by 3ft. in width and 2ft. 9in. in height, it will be seen that they can be readily transported along any roadway where a pit wagon travels; in fact, they are designed to be run about just like an ordinary tub from place to place as convenience may require. When it is desired to set them to work it is only necessary to place a packing of timber under each end so as to scotch the wheels, and to fix a couple of props to prevent the bogey being moved by the load hauled. These engines are made in three sizes, with cylinders of 4in., 5in., and 6in. in diameter, and with strokes varying from 8in. to 12in.

Fig. 2 represents a similar type of engine which is designated as semi-portable, the cylinder being rather larger in diameter, and having strokes of somewhat greater length. These are designed so that they can be taken to pieces and put together again with very little trouble. All that is necessary for the transport of a pair of engines is to separate them into six pieces, an operation which can be effected with great rapidity and with very little trouble. It should be stated that the engines are arranged so that they may be worked either with steam or compressed air.

ROUX'S HYDRAULIC PUMP.*

This pump was designed by Mr. C. Roux, for the utilisation of water columns of great height by means of simple and compact pumping apparatus, capable of moving at high speeds, with efficiency and durability. After having successfully applied his system at the Blanzy mines, Mr. Roux was engaged by Mr. Schneider and Mr. Biauzat to adapt his system to the Creusot coal mines. At these mines the main source of the waters used in the colliery is situated at the Saint Pierre well, at a depth of 1,153ft. A considerable proportion of the water is also collected from the Saint Paul well, which stands at a level 874ft. deep, or (1,153 – 874 =) 279ft. above the level of the main source. The Saint Paul water, therefore, falls through 279ft. by the time it reaches the other well. Now, each cubic metre of water falling through 279ft. is equivalent to 0·242 cubic metre lifted through 1,153ft., or, allowing only 40 per cent efficiency of lifting machinery, to 0·096 cubic metre, or about one-tenth of a cubic metre; and it was proposed, by means of a Roux pump, to utilise the 279ft. fall of the waters from the higher to the lower well, to lift one-tenth of these waters from the lower well, and to that extent to relieve the ordinary pumping engines, which had already been worked up to the limit of their capacity. Mr. Roux's apparatus consists of a large air vessel, besides which are placed, on either side, two horizontal pumps, which may be worked together or separately, and each capable of using the whole of the available water, part of which is lifted to the surface, and the remainder discharged into the lower well.

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* Foreign Abstracts Proc. Inst. C.E.

In each pump three pistons are at work. Being cast together in one piece, they reciprocate simultaneously. The central piston is 14in. in diameter, is double-acting, and forms the motor. The outer pistons are about 5½in. in diameter, are single-acting, and have a common stroke of 10⅕in. A valve box at the outer end of each single-acting pump contains a suction valve and a delivery valve. By the smaller pistons the water is forced up the shaft. There are no piston rods or stuffing boxes. The distribution of water pressure is effected by means of a species of piston valve, which reciprocates by the pressure of the water, in a cylinder about 3¼in. in diameter, placed above and parallel to the motor. A second valve, about 1½in. in diameter, is placed over the large valve, and it is by the reciprocations of this smaller valve that those of the larger valve are effected. The motion of the smaller valve is produced by a small current of water from the working cylinder, through orifices which are uncovered by the piston a little before the end of each stroke. The supply pipe is 8in. in diameter; that for the lift is 5½in.

From the results of numerous trials, made at different times, of the Saint Pierre pump, it appears that, at a speed of 50 double strokes per minute, the apparatus consumes 1,783·52 cubic metres, and lifts 248·42 cubic metres (54,652 gallons), or about one-seventh of the quantity, in twenty-four hours. The disposable fall is only 230ft., and the net lift is (1,153 − 230 =) 923ft.; so that to lift one volume of water through 923ft., seven volumes of water falling through 230ft. only are required, showing an efficiency of 55 per cent. But the results of manometric trials tend to show that the efficiency of the pump itself would be 65 per cent in water lifted, and that the mechanical efficiency would amount to 80 per cent.

The cost of installation at the Saint Pierre well was as follows:—

The machine itself	£872
The pipes	910
Erection and contingencies . .	696
	£2,478

The machine has frequently worked more than a month at a time without having been inspected, and has remained in good order. It has even worked for many days under 25ft. of water.

ALLOYS: THEIR CONSTITUTION AND PROPERTIES.—II.

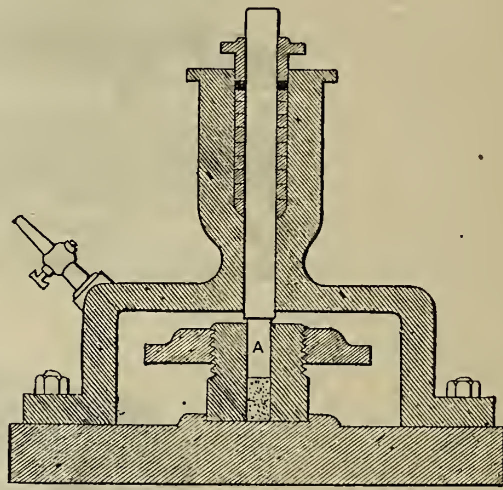
(Continued from page 521.)

The following metals evolve heat when they are united:—Aluminium and copper, platinum and tin, arsenic and antimony, bismuth and lead, gold and just melted tin; while, on the other hand, lead and tin when united absorb heat—that is, produce cold when their union takes place.

In the case of many metals these effects can only be demonstrated by the aid of delicate instruments. I have, however, selected a case in which the union of metals is attended with a considerable diminution of temperature; it is an experiment we owe to Mohr, and it will be shown subsequently that its explanation is a very complicated one. Take tin, lead, and bismuth in equivalent proportions, as finely divided as possible, and mix them with eight equivalents of mercury as rapidly as may be under conditions in which heat is not transmitted to the mixture from the walls of the containing vessel, and it will be found that the temperature falls from the ordinary temperature of the room + 17° C, to − 10° C., so that if a vessel containing water be placed in the mixture the water will be frozen. [The experiment was performed by mixing the finely-divided metals with mercury contained in a glass flask, which became frozen tightly to a wet board on which it stood.] The experiment proves that by the union of metals, using mercury as a solvent, a freezing mixture may be produced, but at present I only want to demonstrate the fact. We shall see in the course of the next lecture that work has probably been done on the molecules of the metals, resulting in the absorption of heat, and the illustration has merely been given here as showing that the union of metals may be attended with the production of cold.

Now let me turn to the second method by which metals may be caused to unite, that is by compressing strongly the powders of the constituent metals. Since 1878, the labours of Professor Walthère Spring, of the University of Liège, have been mainly devoted to the study of the effect of compression on various bodies. The particles of a metallic powder left to itself at the ordinary atmospheric pressure will not unite, but by augmenting the points of contact in a powder the result may be very different. His own experiments were made with the aid of a compression appartus, the general form of the appliance employed being shown in the diagram, fig. 1. Under a pressure of 2,000 atmospheres on the piston, or 13 tons on the square inch, lead, in the form of filings, becomes compressed into a solid block, in which it is impossible to detect the slightest vestige of the original grains, while under a pressure of 5,000 atmospheres lead no longer resists the pressure, but flows as if it were liquid through all the cracks of the apparatus, and the piston of the compressor descends to the base of the cylindrical hole, driving the lead before it. The more interesting results were obtained by Spring with crystalline metals. Bismuth, as is well known, is crystalline and brittle, yet fine powder of bismuth unites under a pressure of 6,000 atmospheres into a block very similar to that obtained by fusion, having a crystalline fracture. Tin, when compressed in powder, unites, and if it is made to flow through a hole in the base of the compression apparatus, the wire so formed sometimes, though not always, emits the peculiar "cry" of tin when bent. The table shows the amount of pressure required to unite the powders of the respective metals:—

Fig. 1.

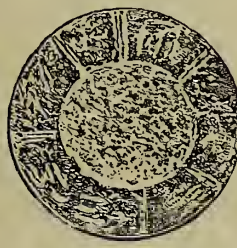


The metallic powder is placed under a short cylinder of steel, A, in a cavity in a steel block divided vertically, held together by a collar, and placed in a chamber of gun-metal, which may be rendered vacuous. The pressure is applied to a cylindrical rod passing through the stuffing-box.

		Tons per sq. inch.
Lead	unites at	13
Tin	„	19
Zinc	„	38
Antimony	„	38
Aluminium	„	38
Bismuth	„	38
Copper	„	33
Lead	flows at	33
Tin	„	47

We know that combinations are produced when certain bodies in solution are submitted to each other's action. But do solids combine? Is the alchemical aphorism, "That bodies do not react unless they are in solution," true? Experiment proves that such solution is not necessary. I have here two anhydrous salts—iodite of potassium, and corrosive sublimate; and these salts are at the same time dry. When they are mixed in this mortar they unite, as is shown by the vermilion-coloured iodite of mercury which is produced. But do solid metals combine in the sense, that is, in which chemical combination is possible between metals when submitted to each other's action under the conditions which prevail when their powders are compressed? Mohr has pointed out that cohesion is a form of chemical affinity, and the experiment I have already shown you of the freezing of water during amalgamation affords valuable evidence in support of his view. It occurred to M. Spring that if there be true union between the particles of a metallic powder when submitted to great pressure, it ought to be possible to build up alloys by compressing the powders of the constituent metals, and he urged that the formation of alloys by pressure would afford the most conclusive proof that there is a true union between the particles of metal in the cold when they are brought into intimate contact. Experiment proved that this reasoning is correct, for by compressing, in a finely-divided state, fifteen parts of bismuth, eight parts of lead, four parts of tin, and three parts of cadmium, an alloy is produced which fuses at 100 deg. C. It is necessary, however, to compress the mixed powder twice, crushing and filing up the block obtained by the first compression, because the mechanical mixture of the constituent metals is not sufficiently intimate to enable a uniform alloy to be obtained by a single compression. The alloy we have produced fuses, you will observe (if you watch the projection on the screen) in boiling water, actually at 98 deg. C., although the melting point of the most fusible of its constituents, the tin, is 228 deg. C. The formation of fusible metal by compression leads me to deal with an objection that may have occurred to many of us. It may be urged that by compressing these powders heat is evolved, and that this heat may be sufficient to produce incipient fusion of the metallic powders, or, at all events, may exert a material influence on the result obtained. This objection has been experimentally anticipated by Professor Spring. First, the compression is effected with extreme slowness, and therefore there can be no question as to the sudden evolution of heat, as would be the case if the powders were compressed impact instead of by a slow squeeze; and to sum the matter up briefly, Spring calculates—taking an extreme case—that if it be granted that all the work done in compressing the powders were actually translated into heat, it would only serve to heat a cylinder of iron 10mm. in height and 8mm. in diameter (the dimensions of cylinder produced in his apparatus) 40·64 deg. C.

Fig. 2.



In order that direct experimental evidence might not be wanting, Spring took the organic body phorone, a hard crystalline substance which melts at 28 deg. C., and compressed it exactly as in the case of the metallic powders. He took the precaution to place a shot of lead on the top of the powder before submitting it to compression. Only imperfect union of the particles of phorone resulted. The conclusion of the experiment proved that the shot remained where it had been placed at the top of the column, and therefore the 28 deg. necessary to melt the substance had not been evolved, for if it had the shot must have fallen through the fluid mass. I think, then, it is absolutely safe to conclude that, in the compression of bismuth, for instance, there can be no question of the evolution of the heat necessary for the fusion of the metal.

It seems to me to be quite safe to conclude that it is proven that *solid* metals possess the power of reacting on each other and forming alloys, provided their particles are really in contact.

We have seen that metals may be made to unite either by compression or by fusion. The formation of alloys by the electrolytic deposition of the constituent metals cannot be dealt with in this brief course of lectures.

We must now examine more closely the mutual relations of the metals when united. Metals may be mixed in the fused state, but it by no means follows that they will remain in admixture if they are allowed to cool slowly, or sometimes even rapidly. In fact, a cooling mass of mixed metals often behaves much as water containing suspended matter does in freezing, when the ice, first formed, rejects the foreign matter, and, as has been shown by the classical researches of Levol, the portion of the alloy which first solidifies rejects certain other portions of the constituent metals. Take this case of lead and zinc: the metals were thoroughly mixed in the fused state, and yet, on slow cooling in a deep mould, the separation has been almost complete, and you will see that it is easy to break off one corner at the side where the zinc has separated itself, and flatten out another one, which proves it to be nearly pure lead. Take, again, this case of what was a triple admixture of lead, antimony, and copper, thoroughly mixed when fluid, and cooled in a cylindrical mould. The copper and the antimony unite, but they reject nearly all the lead and drive it to the centre of the mass, so that the solidified cylinder, when broken across, looks like the diagram (fig. 2), which represents a ring of the purple copper-antimony alloy surrounding a core of lead. Silver and copper alloys behave in a similar manner, but in any mixture of fused silver and copper one particular alloy of silver and copper is formed; this is driven outwards or inwards in the cooling mass according to whether silver or copper is in excess in the bath. In all these cases the separation is never complete—the lead retains some 1·6 per cent of zinc, and the zinc about 1·2 per cent of lead. The copper and antimony retain a small amount of lead, and the lead a small amount of copper and antimony, as is shown by some very careful experiments of my assistant, Dr. E. J. Ball, which have been recently published. The solid mass in all three cases is a mixture of solidified solutions of the metals in each other.

The late Dr. Guthrie investigated this side of the problem at some length. It is difficult to give a brief account of his work, but his conclusions may be stated as follows. He considers that certain alloys in cooling behave as a cooling mass of granite would; clear molten granite would throw off in cooling "atomically definite" bodies, leaving behind a fluid mass which is not definite in composition, as the quartz and the felspar undergo solidification before the mica. In alloys much the same thing happens, for when a molten mass of lead and bismuth or bismuth and tin cools, a certain alloy of the metals falls out, just as the quartz and felspar did, and ultimately the most fusible alloy of the series is left, which Dr. Guthrie called the eutectic alloy. It is the most fusible alloy of the series, but the proportions between the constituent metals are not atomic proportions, and Guthrie says that "the preconceived notion that the alloy of minimum temperature of fusion must have its constituents in simple atomic proportions, that it must be a chemical compound, seems to have misled previous investigators;" but, he adds, "that certain metals may and do unite with one another in the small multiples of their combining weight may be conceded; the constitution of eutectic alloys is not in the ratio of any simple multiple of their chemical equivalents, but their composition is not on that account less fixed, nor are their properties the less definite."

Guthrie only dealt with alloys of low melting points, such as the fusible metals, and it remains to be seen whether the observation will apply to alloys with higher melting points. My impression is that it does apply, at least to the silver-copper alloys, which melt below 940 deg. C. For further information upon this point we must wait for the development of Mendeléef's theory of solution. He regards solutions as strictly definite, atomic chemical combinations at temperatures higher than their dissociation temperatures. Definite chemical substances may be either formed or decomposed at temperatures which are higher than those at which dissociation commences; the same phenomenon occurs in solutions; at ordinary temperatures they can be either formed or decomposed.

In further tracing the analogies between alloys and saline solutions, it will be well to see what takes place when a current of electricity is passed through an alloy. Take first the case of a fluid alloy through which a current is passed. We have spoken of alloys as solutions. If they be ordinary chemical solutions it has been urged that an electric current of sufficient strength ought to decompose them, and it becomes a most important question to determine whether an ordinary metallic alloy can conduct electrolytically like a salt solution, or whether it conducts as a metal would, that is without being decomposed.

(To be continued.)

Public Telephone Line.—A telephone line between Berlin and Dresden, a distance of 105 miles, has been recently opened for the use of the public. The charge for the use of the telephone is about a shilling for every five minutes.

Owens College Engineering Laboratory.—We note that a series of engine trials are about to be made with the experimental triple-expansion engines in the Whitworth Engineering Laboratory, Owens College, Manchester, and those of our student readers who reside within reach of that institution should not miss the present opportunity. The fee for the course is one guinea. We drew attention in our issue of May 4th last to the splendid manner in which this laboratory is equipped, and how well the engines, which have been designed by Professor Osborne Reynolds, were calculated for conducting original scientific investigations with regard to the action of steam in the cylinder of the steam engine.

CORRESPONDENCE.

We do not hold ourselves responsible for the opinions of our Correspondents.

EXTRACTION OF FOURTH AND FIFTH ROOTS.

To the Editor of "The Practical Engineer."

SIR,—Noticing your reply to "J. P. W." in last week's *Practical Engineer* with regard to the extraction of the fourth or fifth root of any number, I beg to enclose a purely arithmetical method, which I trust may be interesting to some of your readers. Although it is not as short as by logarithms, yet it is always at hand, being easily remembered.

Rule for extracting any root of a number. Example: Required the fifth root of 380,204,032.

0	0	0	0	380204032
5	25	125	625	3125
—	—	—	—	—
5	25	125	625	67704032
5	50	375	2500	67724032
—	—	—	—	—
10	75	500	31250000	
5	75	750	2562016	
—	—	—	—	
15	150	1250000	33812016	
5	100	31008	—	
—	—	—		
20	15000	1281008		
5	504	—		
—	—			
250	15504			
2	—			
—				
252				
—				

Answer: 52.

Make as many columns as there are units in the index of the root to be extracted (in this case 5); place the given number at the head of the right-hand column, and ciphers at the heads of the other columns. Commencing at the right hand, separate the given number into periods of as many figures as there are columns (5); extract, by trial, the root required of the left-hand period (3802), to within unity, for the first figure of the root. Add this figure (5) to the figure in the left-hand column (0); multiply the sum (5) by this first figure (5), and add the product (25) into the second column; multiply this sum (25) by the same figure and add to the third column, and so on, placing the last product in the right-hand column under that period of the given number from which it was derived; subtract this from the figures above it; add the same figure (5) into the first column again, multiply the sum by the same figure again, and add the product into the second column, and so on, dropping one column to the right at each row, until all the columns have been so dropped. Annex one cipher to the number in the first column, two ciphers to that in the next, and so on, taking down the next period in the right-hand column instead of adding ciphers. Divide the number (67,704,032) in the last column by the number (31,250,000) in the previous column, making allowance for completing the divisor; this will give the next figure in the root, which is to be used in exactly the same manner as the others. Proceed in like manner until all the periods in the given number are used.

Enclosing my card, I beg to remain, yours truly, JANEY.

Partick, Oct. 31, 1888.

PATENTS FOR INVENTIONS.

To the Editor of "The Practical Engineer."

SIR,—I read your paper regularly with interest and considerable edification, being myself an engineer practising much in those branches you are strong upon, viz., engine, boiler, and contingent work, and also as a patent agent.

In your leader of October 26th, on the new patents, &c., bill, however, you follow the (to my view) erroneous lead of your "oldest engineering contemporary," and though your argument against making the profession of a patent agent "closed" might have some strength if that were the intention of the bill, yet you do not in any way seem to remember the motto, *Audi alteram partem.*

It has all along appeared to me extraordinary that such opposition should be raised by the public to a measure, so far as I can see, proposed entirely in its interests; and certainly all the arguments I have read against its passage into law strike me as being singularly weak. The statement in your article, that the "Act of 1883 put inventors in such a position that anyone understanding ordinary English could draw up a specification with the certainty that the law would uphold anything new which he had described," is entirely erroneous. Inventors have always been free to draw their own specifications and obtain patents without professional assistance if they liked, and, of course, at their own risk. The Act of 1883 did not alter this position, but it by no means enacted it to be "a certainty that the law will uphold anything new he had described," as you state, unless he had described and claimed that new thing fully and properly. It is difficult enough for an experienced patent agent to properly describe and claim some inventions, bearing in mind, as he would essentially do, a mass of case law and facts based on years of practice and study. No doubt it would be much easier for the inventor himself, with mind totally unembarrassed with "decisions," to dash off a description of his own invention. But of what legal value is such a specification? Everyone should admit that if an invention is worth protecting at all, it is worth protecting fully and properly.

At present anybody can and may, as a contemporary remarked, "take a room in Chancery Lane, and stick up 'Patent Agent' without any qualification whatever." With the present lack of statutory qualification of agents, any member of the public is as likely as not to fall into the hands, not necessarily of a sharper or rogue, but of a so-called patent agent, utterly and entirely ignorant of patent statute law or case law, and perhaps only but little versed in the ordinary practice of the Patent Office. I am not conversant with the solicitors', doctors', dentists', or veterinary surgeons' Acts, but I believe the public is protected from fraudulent practitioners in all of these professions, and surely the profession of a patent agent should be on all fours.

There is nothing in the new bill to prevent a penman or an engineer helping an unpractical inventor with his specification, but what is intended and what is wanted is to prevent that penman and that engineer holding himself out to the general public to be an expert in that which is not his calling, viz., patent law and practice, simply because he can drive a fluent pen, or knows something of mechanics, or has assisted inventors in perfecting inventions.

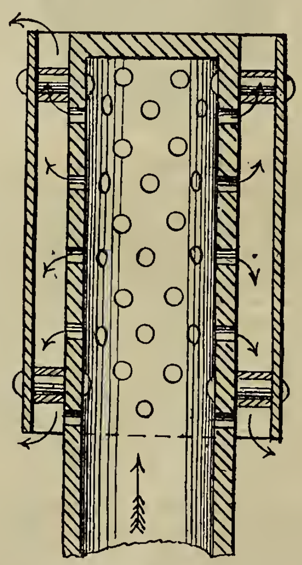
We see too many samples of these gentlemen's work; the Patent Office records, of late years particularly, teem with them.

London, Nov. 5th, 1888. J. C. CHAPMAN.

QUERIES AND REPLIES.

ROARING OF STEAM.—It often occurs that our engine is suddenly stopped, with good fires under boilers. After opening doors, &c., a 3in. valve on main steam pipes is opened to relieve pressure. This blows up through roof, and the roaring is rather an annoyance to the neighbourhood. Now, I should be glad of some plan for stopping this. I have heard that the roar may be completely deadened by blowing into a box filled with stones or broken glass. Can any reader say, from experience, that this is correct? I have also seen exhaust pipes of engines projecting through roofs fitted with a sort of inverted cone arrangement on the top. What is this for?- FIREMAN.

Answer.—In reply to "Fireman's" query, I enclose a sketch showing an arrangement used on exhaust pipes for suppressing noise, consisting of a sleeve or pipe fitted to the exhaust pipe with an annular space between the two. The end of the exhaust pipe is stopped up, and a number of small holes are drilled in the pipe, the united area of the whole number exceeding the area of the exhaust pipe by about 20 per cent. The ends of the sleeve are both open for the exit of the escaping steam upwards or downwards, the sleeve being held in position at each end by bolts, or by rivets and ferrules, as shown.—F.



VENTILATION OF MINE. —May I take the liberty of asking the following questions through your paper: A section of workings in a pit is connected to some old waste workings where much inflammable gas is given off. If compressive ventilation is adopted, would it have any advantage over that caused by an exhaust fan? Further, can any reader give me a good rule for finding the amount of "draw" to allow when approaching buildings, so that they may not be damaged, first under ordinary circumstances, and also when there is soft material near the surface.—T. H. W.

Answer.—There is a slight advantage in compressive over exhaustive ventilation in the case named by "T. H. W." Supposing that 2in. water gauge were obtained in each case, there would be an advantage of 4in. water gauge, or nearly 21lb. per square foot more pressure against the gas in the "goaf" when compressing. This advantage is, however, in most cases more than compensated by the practical working difficulties attendant on ventilation by compression. The second part of his question opens out a great field of discussion. The ancient rule stated that the draw of the mine was at right angles to the seam, but this does not work out for very flat or very steep mines, or great depth, the truth being that the draw is something outside the perpendicular to the surface, which depends on the nature of the strata, faults, and other surroundings of the particular case. The writer has met with a case (but this was a most extreme one, when the dip of the mine was over 60in.) where the draw followed the mine itself up towards the rise, and caused the ground, a pit, engine-house, &c., to slide bodily down the dip. If there is a soft material at the surface, say sand and gravel with water in it, it is impossible to foresee the extent of the area of subsidence, as the whole of the portion from which water is removed will be affected.—H.

Answer.—The most effectual and economical way of keeping the old waste so clear of gas as to be safe, is to lay air pipes from that edge or boundary of the waste or "goaf" adjoining the present workings to some considerable distance into it, and then to connect the end of the pipe immediately outside the goaf to a pipe leading to an exhausting fan, by which means the fan will draw all the foul air from the chinks and crannies in the goaf, which will be replaced by fresh air from all sides of the goaf on which it is accessible.—W. A.

Filtering Waste Water of Dyeworks.—I should feel obliged for any information as to the best and most economical method of cleansing about 200,000 gallons of water per day leaving dyeworks. This water has a very high percentage of logwood extract refuse, which would require to be removed before leaving the works.—Cleansing.

Answer.—We should think the large filters manufactured by the Pulsometer Engineering Co., of Nine Elms, London, would suit your requirements, as they are specially designed for treating large quantities of muddy and impure water. You might at any rate communicate with them on the subject. You will find an illustrated notice of the filters we refer to in our issue of September 7th last, page 426.—Ed.

Specific Gravity of Sea Water.—I should feel much indebted for assistance from you or any of your numerous readers with the following question: A vessel, consisting of a pipe closed water-tight at each end by pistons, which slide inside the pipe, thereby increasing or diminishing the total volume, floats $\frac{9}{10}$ vol. submerged in sea water, when expanded to its greatest extent. By the addition of a certain quantity of sea water the vessel is sunk just under the surface of the water. By means of the pistons its volume is now diminished, causing it to sink. Required, the proportion of this diminution to the total original volume per 100 fathoms sink? Also, How does the specific gravity of sea water vary on an average with the depth from the surface, and between what limits?—Janey.

Answer.—Without further and more explicit information from "Janey" as to the conditions of his problem, it is impossible to answer his question. He does not tell us whether the water admitted into the vessel totally or only partially fills up the space between the two pistons, nor whether on the pistons approaching each other they merely diminish the space between them without compressing the water (as its volume may be smaller than the inclosed space), nor whether the inclosed water is compressed by their approach; nor does he say whether external force is applied on the pistons, or merely the hydrostatic pressure of the sea water, due to the depth at which they may be. If he will kindly furnish information on these points, I will endeavour to assist him.—W. A.

Lap of Slide Valve.—I should be glad if you could give me some information how to calculate the lap of slide valve, in order to secure any given cut-off, and whether such calculations can be made by means of ordinary arithmetic. Are there any books that would supply me with the above information?—

Answer.—The question you refer to has been dealt with very fully on several occasions in our columns. In our issue for October 28th, 1887, we gave an article on the subject, accompanied with a table showing at a glance the amount of lap required for any point of cut-off, or *vice-versa*. In our issue for November 4th, 1887, we gave a graphic diagram, by means of which the required lap for a valve for any desired cut-off could be obtained at a glance, without any calculation. Again, in our issue for December 9th, 1887, another somewhat similar diagram was furnished. A reference to these should give you all the information you require.—Ed.

Helical Wheels.—Can any of my fellow-readers inform me of the best mode of setting out the teeth of a pair of bevel helical wheels, the larger wheel to be 34·8in. diameter, with 6in. face and 73 teeth, 1½in. pitch, and the smaller one or pinion 18·14in. diameter, with 6in. face and 38 teeth 1½in. pitch? Also a plain spur wheel 77·98in. diameter, with 140 teeth, 1¾in. pitch, to work in a pinion 40·1in. diameter, with 72 teeth. Any information with regard to making the patterns would oblige.—J. W. J.

Would some reader kindly inform me what is the proportionate strength of helical wheels in comparison with spur wheels having similar diameter, pitch, and face; also what is the rule for finding the breaking strength of helical wheels?—W. R. E.

Answer.—It is our intention to give one or two articles on the subject of helical wheels.—Ed.

Bronzing Iron and Steel.—Would some reader of your valuable paper kindly furnish me with a recipe for bronzing iron and steel?—Driver.

Joy's Valve Gear.—I hope the question of "G. H." regarding Joy's valve gear will be fully answered, and if you could accompany the answer with a sketch it would, I think, be of interest to a many of your readers.—Japan.

Incrustation in Surface Condenser's Tubes.—Can any reader inform me how to remove the incrustation from the inside of the tubes of a surface condenser of a land engine? The deposit is very hard and tenacious, and consists almost entirely of carbonate of lime.—Nemo.

Joy's Valve Gear.—Can any of your readers tell me how the valves are set in an engine when Joy's valve motion is adopted? Also, how to get the lead of valve? Suppose a valve to have ½in. lead, and it is desirable to increase it to $\frac{3}{16}$in., how would you operate?—G. H.

Plumbago Crucibles.—I should be obliged if some correspondent would kindly inform me what is the composition which is used in the manufacture of black lead or plumbago crucibles.

Diagram of Stress for Girder.—I should be obliged for any information regarding the most correct method of setting out a parabola for a uniformly-loaded straight girder, supported at both ends, showing line of stress and how to fix length of plate by same. One method I know is to draw the flange plates full size vertically, and make the central vertical line equal to the height thus obtained. But is there not another method of setting up the centre vertical line by taking the areas of the plates and angle irons consecutively?—Gyrtona.

Weighing Machines.—Is there any book published dealing specially with the construction of these machines, and what is the price?—T. D.

Chilled Furnace Bars.—Can any of your readers give me any information with regard to chilled furnace bars? To what depth can they be chilled from the top surface? Is it difficult to cast chilled bars any length—say 6ft.? What difference does it make in the nature, temperature of fusion, and also cost as compared with ordinary furnace bars?—Durability.

Hoppers for Grinding Mills.—Having a number of hoppers to make for a grinding mill, I shall be obliged if some reader would give me a rule other than rule of thumb for finding the proper bevil to plane the corners to.—A Country Millwright.

Hydraulic Ram.—Can any reader oblige me with a sketch and rules for proportioning a modern hydraulic ram, such, for instance, as the "Galiban" ram? I have studied the description of the hydraulic ram given in Rankine's "Prime Movers," but the sketch there given is very obscure, and I cannot follow the action of the waste water valve.—Querist.

TO CORRESPONDENTS.

J. Robinson.—The matter referred to in your letter has not escaped our attention, but the demands upon our space have grown so rapidly that it was felt to be impossible to deal with the subject of science examinations as fully as would be necessary without some risk of excluding more important matter. As you will see from this week's leader, the increasing pressure on our columns is compelling us to enlarge our journal, and, as you can easily understand, with such a large circle of readers as we possess, it is extremely difficult to meet the wishes of every class, and we have to proceed on the basis of meeting the widest wants of the greatest number. Thanks for your kind wishes.

W. H.—The answer to your query, regarding carriage springs, in last week's issue was given under a little misapprehension. The expression $\frac{a^2 + b^2}{b}$ represents the diameter of the circle, of which the spring forms only a portion. An easy rule for the length of the arc is the following: From eight times the chord of half the arc subtract the chord of the whole arc, and one-third the remainder is the length of the arc required. The chord of half the arc in the case given is the square root of $27^2 + 6^2 = 28$, and the length of the arc is $8 \times 28 - 54 \div 3 = 55\frac{1}{2}$in. as nearly as may be. Thank you for calling our attention to the matter.

Engineman.—We have no knowledge of the patent steam boiler you refer to, but you will need to accept the statements that have been made to you regarding its economy with a very large grain of salt. Even if the heating surface be doubled, it does not necessarily follow that such an increase is advantageous or would result in additional economy. To say that any boiler would be able to perform half as much work again for the same quantity of fuel as a well-designed Lancashire boiler is simply nonsense.

Like you, we consider the remarks of the magistrate anent boiler attendance as quite uncalled for, and as a gross slander on a hardworking body of men. The great unpaid have never been conspicuous for wisdom, and we should attach very little importance to their opinions on technical matters. The best way to deal with such statements is to treat them with silent contempt. To honour such statements by publicly noticing them would not add anything to our dignity.

Innocentia.—As you will see, from the reply to "W. H." above, the answer to the query regarding length of carriage spring in last week's issue was erroneous, and given under a little misapprehension.

Janey.—Such a rule as you describe would undoubtedly be very useful to some persons occasionally, but we question if its utility would be sufficiently general to insure a sale large enough to repay you for your trouble. Multiplication and division are operations more frequently performed and more apt to lead to serious mistakes than simple addition, and the Gravet slide-rule enables these to be effected with great facility and ease.

MISCELLANEA.

Explosion of an Esparto Boiler.—On the 27th ult. a boiler used for steaming esparto grass burst at the North of Ireland Paper Mills, Ballyclare, Co. Antrim, killing one man and seriously injuring several others.

Heavy Railway Rails.—Steel rails, weighing 90lb. per yard, have recently been rolled by the Bethlehem Iron Company, of Bethlehem, Pa., for use on the Reading railroad. They are the heaviest steel rails ever rolled in the States.

Long Railway Bridge Span.—The longest railway bridge span in the United States is now the cantilever span in Poughkeepsie Bridge, 548ft. This is said to be the widest *completed* railway span in the world. The great Forth Bridge, now in process of construction, will have a span of upwards of 1,700ft.

The Eiffel Tower.—The Eiffel Tower, at Paris, has now reached a height of 178 metres, or 569ft. The remaining 122 metres to be yet constructed will, it is expected, be completed by the end of January. The total height of the tower when finished will be 1,000ft. as nearly as may be.

Ærial Navigation.—Mr. John Sangster, of Sherborne Lane, London, has placed at the disposal of the Council of the Balloon Society £1,000 towards a fund to reward the first ærial navigator who solves the problem of scientifically conducting a machine through the air in the same manner as ships are now navigated through the water.

Natural Galvanic Battery.—A "natural battery" has been found at Nova Scotia, near Bridgewater, where a telephone line runs to the mines, about thirty miles distant. A current of electricity was found in the line, which is attributed to the "natural battery" formed by the mineral deposits of copper, silver, lead, and iron ores in the vicinity of the gold mine.

Discovery of Mica.—A discovery of mica has, it is said, been made by Mr. D. Lindsay, F.R.G.S., in the northern territory of Australia. Sample slabs have been sent over to the Society of Arts, and one of the two main outcrops at present discovered is said to be about 30ft. in width. As the use of mica in the construction of electrical apparatus is rapidly extending, and as large sheets are valuable, the discovery may prove of great importance.

Attaching Paper Labels to Metallic Surfaces.—Considerable difficulty is experienced in attaching paper labels to metallic surfaces by means of gum or paste, and if the surface is bright the label pulls off with very slight provocation. The difficulty, however, is said to be easily overcome by washing the surface of the metal with a strong and hot solution of washing soda, afterwards rubbing perfectly dry with a clean rag. Onion juice is then applied to the surface of the metal, and the label pasted and fixed in the ordinary way. It is said to be almost impossible to separate paper and metal thus joined.

Forgings by Private Firms for the Government.—Speaking at Sheffield on Tuesday, the 30th ult., Mr. Stuart Wortley, M.P., said the Government were encouraging production by private firms. Referring to the assertion that only 2,700 tons of orders had been given to Sheffield, he said that represented only the proportion which was given to Sheffield of nearly 6,000 tons of orders for forgings which were given in three years to private firms. In addition to that, in 1885 alone, Armstrongs and Whitworths had orders for finished guns to the number of 114 of Armstrong's and 24 of Whitworth's, which probably represented some 5,000 or 6,000 tons of forgings. The orders for finished guns had to be given outside Woolwich, because Woolwich could not work fast enough to make up the armaments. The policy of encouraging the private traders with orders and increasing and spreading the sources of our supply of armaments had been extended. Mr. Stanhope had promised 75 per cent of the orders to the private traders, and at that moment they were actually getting more than that proportion. The first order for finished guns ever given to Sheffield had just been placed by the present Government, and in addition to that there were now large orders for forgings under execution in Sheffield alone valued at something like £260,000.

Explanation of the Sound of Thunder.—One of the best descriptions of a common natural phenomenon is that recently given by M. Hirn, in which he says that the sound which is known as thunder is due simply to the fact that the air traversed by an electric spark—that is, a flash of lightning—is suddenly raised to a very high temperature, and has its volume, moreover, considerably increased. The column of gas thus suddenly heated and expanded is sometimes several miles long, and, as the duration of the flash is not even a millionth of a second, it follows that the noise bursts forth at once from the whole column, though for an observer in any one place it commences where the lightning is at the least distance. In precise terms, according to M. Hirn, the beginning of the thunder clap gives us the minimum distance of the lightning, and the length of the thunder clap gives us the length of the column. He also remarks that, when a flash of lightning strikes the ground, it is not necessarily from the place struck that the first noise is heard. Again, he points out that a bullet whistles in traversing the air, so that we can, to a certain extent, follow its flight, the same thing also happening with a falling meteorite just before striking the earth. The noise actually heard has been compared to the sound produced when one tears linen. It is due really to the fact that the air rapidly pushed on one side in front of the projectile, whether bullet or meteorite, quickly rushes back to fill the vacuum left in the rear.

Recent Locomotive Practice.—At a general meeting of the King's College Engineering Society, London, held on October 25th, the president in the chair, Mr. Barratt read a paper on "Recent Locomotive Practice." The author commenced by stating that at the present day locomotives are taxed to their utmost capacity, and it is when they are thus taxed that the slightest peculiarity in their design or management becomes apparent. For the purposes of the paper, the author divided locomotives into three classes—(1) single, (2) coupled, (3) compound, and described the special features of a typical example in each case. With regard to single engines, he pointed out that beside the advantage of adhesion which the large wheel possessed, there was also with it less back pressure when travelling at high speeds, as the piston speed is not so great as with a small wheel. He also stated that the adhesion of single engines had been much increased by the use of Messrs. Holt and Gresham's steam sanding apparatus, the details of which were given. Referring to compound engines, the author showed that with very high pressure steam it was economical to take advantage of the increased amount of expansion, but as the rate of expansion is increased in any cylinder the loss arising from liquefaction is increased in similar proportion; hence by partly expanding the steam in one cylinder and completing the expansion in another we eliminate the great variations of temperature in the same cylinder, which are so prejudicial. The author then described the application of this system to locomotives by Mr. Webb, of the North-Western, and the Worsdell and Van Borries system, as applied by Mr. Worsdell to the engines on the North-Eastern Railway, and also by Mr. Holden to the Great Eastern Railway, giving the figures and working details in each case. After a vote of thanks to Mr. Barratt the meeting adjourned.

SELECTED PATENTS.

APPLICATIONS FOR LETTERS PATENT.

October 26th.

15408	Motors, A. Higginson, Liverpool.
15413	Riveting, F. J. Taylor, Liverpool.
15424	Lubricators, S. Smirke and E. Tate, London.
15437	Heating Feed-water, W. R. M. Thomson, Glasgow. (A. W. James, India.)
15441	Furnaces, F. Ransome, London.

October 27th.

15453	Hand-drilling Machine, G. Mole and J. Pearson, Newcastle-on-Tyne.—[Complete Specification.]
15464	Valves, W. Cunningham, Glasgow.
15466	Tunnelling Machines, B. Stanley, London.
15475	Reducing Valves, J. D. Churchill, London.
15481	Pistons, &c., T. M. Howkins, Liverpool.

October 29th.

15509	Valves, T. Pratt, Keighley.
15515	Drilling Machines, J. E. Rogers, Tipton.
15521	Steam Trap, J. Wood, Manchester.
15545	Brakes, W. E. Gedge, London. (J. R. Bell and F. E. Robertson, India.)
15546	Reducing Valves, W. Reid, London.
15554	Stone-breaking Machines, A. Hope, London.
15557	Pumps, P. E. Hodgkin, London.
15563	Valves, J. L. Stevenson, London.
15566	Driving Belts, J. Johnstone, sen., Glasgow.
15568	Guards, B. Richardson and E. Dickinson, London.
15571	Dredging Vessels, A. Brown, London.
15572	Silicium Copper, W. Feld and G. von Knorre, London.

October 30th.

15584	Grist and Roller Mills, R. Burns, Birmingham.
15586	Moulding Bricks, R. B. Lyon, Newcastle-on-Tyne.
15587	Cleaning Tramway Lines, J. Stark, Liverpool.
15592	Steering Gear, J. Cran, Glasgow,
15594	Ploughs, J. McCall, Manchester.
15595	Points, J. T. Williams, Swansea.
15603	Gas Engines, G. I. Hurst, London.
15604	Bleeding India-rubber Trees, C. Melhado, Holborn. (F. A. Blancaneaux, British Honduras.)
15606	Metal Pipes, G. H. Lloyd, A. L. Lloyd, and H. Bewlay, London.
15607	Turning Ingots, T. K. Cavill, Sheffield.
15616	Meters, H. Meinicke, London.
15619	Nuts and Washers, G. Dunham, Middlesex.—[Complete Specification.]
15620	Cocks, Valves, &c., W. P. Thompson, Liverpool. (J. Cortella, Belgium.)
15625	Pistons, O. H. Steen and M. McDonald, London.—[Complete Specification.)
15626	Electric Batteries, P. Schoop, London.
15627	Carbonising Steel, M. A. Howell, Holborn.
15628	Horse Shoes, J. A. Burden, London.—[Complete Specification.]
15629	Metallic Packing, H. H. Lake, London. (T. Tripp, United States.)—[Complete Specification.]
15631	Securing Railway Rails, A. B. Ibbotson, London.
15632	Tubular Boilers, K. Gamper and R. Farkacz, London.—[Complete Specification.]
15634	Caster or Dredger, A. F. E. Grant, London.
15636	Wire Cloth, A. Knox, Glasgow.
15637	Feeding Furnaces, W. E. Allington, London.—[Complete Specification.]
15639	Cocks and Valves, H. Edwards, London.
15644	Clearing Regenerative Hot Blast Stoves, C. Cochrane and J. English, London.
15651	Frictional Gearing, G. F. Evans, Middlesex.—[Complete Specification.]

October 31st.

15657	Coupling Pipes, E. Fitt, London.
15658	Electro-magnets, H. Marrian, London.
15662	Gas Holders, B. Brown, Liverpool.
15666	Moulds, J. Baker, Middlesex.
15668	Wood-planing Machines, W. Smith, Birmingham.
15672	Dobbies, J. Ward and J. Ward, Halifax.
15677	Wheels and Axles, E. C. S. Moore, Dover.
15682	Bending Wires, A. Stratton and J. Rudge, Redditch.
15686	Siphon Head, E. Radvànyi, London.—[Complete Specification.]
15687	Automatic Chain, J. R. Tozeland, London.
15688	Securing Tubes of Boilers, T. Campbell, Sydenham.
15694	Billets, Wire Rods, &c., J. B. Bradshaw, Shefield.—[Complete Specification.]
15698	Depositing Metals, A. Lévy, London.
15699	Life-guards, C. A. E. T. Palmer, London.
15704	Steam Engines, G. W. Hart, Middlesex.
15705	Bearing Parts of Machinery, G. W. Hart, Middlesex.
15706	Steam Generating Apparatus, G. W. Hart, Middlesex.
15716	Pressure Regulating Apparatus, H. H. Lake, London. (N. C. Loke, United Stated.)—[Complete Specification.]

November 1st.

15721	Cast-iron, J. Pointon, Huyton.
15727	Drilling and Tapping, J. Ruscoe, Hyde.
15733	Steam Boilers, T. Carter, Sunderland.
15734	Stoppers, Cocks, &c., N. White, London.
15735	Gas and Air Flues, I. Beardmore, Glasgow.
15740	Machine Belting, A. Kennedy, Belfast.
15741	Dynamo-electric Machines, P. V. McMahon, Louth.
15744	Jacquard Machines, W. Barras and J. Harrison, Halifax.
15760	Gauges, W. B. Williamson, Middlesex.
15762	Steam Generators, J. S. White, G. E. Belliss, and A. Morcom, Middlesex.
15770	Valves, I. Beardmore, Glasgow.
15772	Screwed Stays, J. C. Wilson, London.
15783	Equilibrium Steam Trap, J. Dixon, London.
15791	Locking Nuts, F. Purbrick and R. H. Stone, Liverpool.—[Complete Specification.]
15793	Bellows, W. Logan, Liverpool.

PUBLISHERS' ANNOUNCEMENTS.

BACK NUMBERS of "The Practical Engineer," from the commencement, can be obtained at either of our offices in London or Manchester, or by order of any Newsagent.

Vol. I. (bound), containing Nos. 1 to 44 inclusive, from March to December, 1887, price 6s. 6d., can still be obtained by order from any Newsagent, or will be forwarded, carriage paid, from either of our offices on receipt of the amount by postal order or stamps.

Numerous complaints having been made to us by Subscribers of the difficulty they experience in obtaining copies of the *Practical Engineer* in certain districts, we have to state that the Journal can be obtained by any Newsagent through the ordinary trade channels, and no difficulty should therefore exist in obtaining copies *by order* of any Newsagent.

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EDITORIAL NOTICES.

All communications for the Editor of this Journal should be addressed to 6, Victoria Station Approach, Manchester.

Communications intended for insertion in the current week's issue should reach us not later than Tuesday Evening.

We cannot undertake to return rejected manuscripts or drawings unless accompanied by a stamped and directed envelope.

Contributors are requested to write on one side only of the paper. Sketches should be sent on separate sheets.

TO ADVERTISERS.

Advertisements intended for insertion in the current issue should reach us on Wednesday morning at the latest.

TO OUR READERS.

As we explained in our leader last week, the price of *The Practical Engineer* will, on and after the 23rd of the present month, be *increased from 1d. to 2d.* Concurrently with the increase in price the size of the Journal will be *permanently enlarged*, while it will at the same time be printed on superior paper and also be enveloped in a neat tinted cover. We are pleased to note from the numerous letters we have received from our readers and friends that the contemplated change meets with their unanimous approval.

THE
PRACTICAL ENGINEER.
NOVEMBER 16TH, 1888.

COMPETITIVE EXAMINATIONS.

THIS burning subject is likely to provoke much discussion if the recommendation of the writers and signatories of an article thereon, which appears in the current number of the *Nineteenth Century*, is followed. Professors Max Muller, Freeman, and Frederic Harrison, and 414 gentlemen famed in the walks of literature, science, art, and education, desire that a petition be presented to Her Majesty, praying for the appointment of a Royal Commission to consider the whole subject of official appointments by examination. They also desire that governing bodies, heads of colleges, &c., be requested to collect information and issue reports bearing thereon.

This protest, vigorous alike in language and in spirit, is made with the view of calling attention to, and if possible modifying, the system under which the work of education is at present conducted. The writers desire the exclusion of the dangerous mental pressure, and misdirection of energies and aims which is alleged to be a direct result of the competitive examination system that prevails in all our scholastic institutions, and which is the avenue to Government appointments. They also say that the present system tends to the cultivation of a quick superficiality—incapacitating for the undertaking of original work; that we have made of our education a body without a soul; that under our prize system all education tends to be of the same type; that both the teacher and pupil are morally depressed and incapacitated by a system that deliberately sets itself to appeal to the lower side of human nature; and that in consequence mental disinclination supervenes to undertake work which is not of a directly remunerative character. They charge the system with being productive of grave physical and moral evils—physical, because the energy which should go to form bone, muscle, and tissue is drawn away by mental overstrain; moral evils due to the low ideal of education set forth, namely, mere prize winning.

There is so very much to be said in favour of competitive examinations, that we fear little good will follow from this truthful protest except possibly it be in the way of the amelioration of some of the worst features of the system. Although fierce academic competition may mean misery and injury to the finer and more delicate natures, yet for the lower, more selfish, more indolent, payment by results is the only working scheme apparent by which they can be trained to fill useful positions in life. Where a few study and work for the love thereof, the many will only do so in the hope of winning life's prizes. However we may deplore the evils which result from this fact, we have to take things as they are, and make the best of existing circumstances. Sluggish and indolent natures need the spur and the whip; they are not susceptible to the allurements of the higher intellectual life, and for these there must be the dead plodding, and, if need be, the severe work of competitive examinations.

The only remedy in which we have much confidence lies in the gradual elevation of the ideal of education. When education comes to be regarded in its true aspect—as a leading or drawing out, a development of the mental faculties, as a growth of mental power, a capacity for assimilation—instead of a cramming with undigested facts, then, and not until then, will the evils incidental to competitive examinations cease. To a mind well prepared by previous *culture*, all knowledge becomes easy of acquisition; to a mind which is overcrammed, knowledge is distasteful, and its acquisition is of the nature of task work. Were our ideals and aims more elevated, then the present evils of competitive examinations would partly or wholly disappear.

THE GLASGOW EXHIBITION.

So far as the general public is concerned, Glasgow International Exhibition was closed on Saturday last, the 10th inst., but the official closing ceremony was deferred until Monday afternoon. The guarantee fund, it will be remembered, amounted to £300,000. The exhibition was opened by the Prince and Princess of Wales on 8th May last, and since then 5,748,379 individuals have passed through the turnstiles. The exhibition was twice visited by the Queen, and among other distinguished visitors were the Duke of Cambridge, Princess Louise, the Marquis of Lorne, and Princess Beatrice. The lowest daily attendance was 16,000, and the highest 117,901, which was registered on Saturday. The season tickets sold numbered 46,000, of which over 33,000 were sold at a guinea, and the remainder at half a guinea ; so that the revenue from this source alone was nearly £42,000. The aggregate gate money amounted to £118,938 9s. There was also a considerable revenue from the switchback railway, over which about 1,200,000 passengers travelled. The attendance on Saturday formed a fitting close to the exhibition. The admissions for the day numbered 117,901. By payment there were 42,077 adults and 9,087 children (representing about £2,500) ; by railway and other coupons, 3,047 ; by season tickets, 60,767 ; and by attendants' passes, 2,423. The grand total for Manchester was 4,765,137, and for the Colonial 5,550,749 ; so that the figures for Glasgow compare favourably with the two exhibitions mentioned, though it should be borne in mind, in instituting a comparison, that in the Glasgow total the attendants are included. We understand the surplus at Glasgow will not be quite so large as that which resulted from the Manchester Exhibition.

LABOUR STATISTICS.

A BLUE-BOOK has just been presented to Parliament, containing the second report, accompanied by statistical tables relating to trade unions, of Mr. Burnett, the labour correspondent of the Board of Trade. In this report, which is addressed to the Assistant Secretary of the Commercial Department of the Board of Trade, Mr. Burnett describes the difficulties met with in obtaining the desired information from the various trade societies. In October, 1887, circulars were sent out to all known unions, together with forms to be filled up, if possible, with information regarding the working of these societies. Comparatively few returns had been made by the middle of March, when a second short circular pressing for a reply was issued, and after that date they came in rapidly. Although a great number of societies made no returns at all, they were mostly small ones, and those which made returns possess members amounting to nine-tenths of the whole body of unionists on the list of the Registrar of Friendly Societies, who is the only official who has a statutory power to ask for information from unions, and that only for certain special purposes. The Registrar's list shows a total membership of 340,893 persons, and the unions which have voluntarily reported to the Board of Trade represent 307,180 persons, so that the result of the issue of the circulars has been pretty satisfactory.

After giving the number of members of the various societies who filled up the returns, Mr. Burnett goes on to say that the publication of such figures will tend greatly to correct the generally prevailing notion that the sole object of trade unions is to foster and encourage strikes, and that most of their funds are applied to that purpose.

In addition to the tables of income and expenditure, several special tables are published, showing the rates of wages and hours of labour fixed in various localities by such trade unions as report on those points.

The reports of the various societies for 1887 are of a much more reassuring kind than those which were returned for the year 1886, and show that trade did undoubtedly improve, and as the year went on the percentage of unemployed steadily decreased. There has thus been in most cases an increase of members and of funds.

Alluding to the reports of the chief officers of some of the societies, extracts from which are published in the blue-book, Mr. Burnett remarks that "they show, above all, that on the whole the counsels of the leaders of the trade union movement are cautious and moderate in the extreme; that these men do not act the part of social disturbers or industrial incendiaries, inflaming the passions of their constituents, but that, on the contrary, when they make their annual addresses they confine themselves to remarks which are distinguished by reason and moderation."

GLASGOW AND WEST OF SCOTLAND ENGINE-KEEPERS' ASSOCIATION.

THE inaugural meeting of this association for the season was held in Glasgow on the 7th inst., Baillie Wallace in the chair. The Chairman referred to the benefits which the engine-keepers derived from the examination which the men underwent at the hands of the Examining Committee, as also the confidence which it gave steam users in having in the members of the association a high class of enginemen. Mr. R. D. Munro, the convener of the Examining Committee, reported that during the eighteen months of the society's existence 70 members had passed the examination for certificates of the various grades, and that the influence of the association was being felt and recognised by the leading steam users in the west of Scotland. Many of these were now making it a condition that their enginemen must have certificates from the association. He also referred to the interest that was being taken in the movement in various parts of England and Wales, and said he felt confident that a few years would suffice to make it national, so that by private effort a body of trained engine-keepers and boiler attendants would be provided without Government interference of any kind. Mr. William Lorrimer afterwards delivered a lecture on the origin and history of the steam engine, and its effect on the progress of the world. He made special reference to the ingenuity and perseverance of the early engineers, and pointed out that with honest application there was no limit to the progress which might be made by those who were engaged in one of the most important branches of industry. The lecturer then referred to the condition of things which prevailed before the introduction of the steam engine, and gave various striking illustrations of the marvellous changes which the various inventions had brought about, and then proceeded to deal more particularly with the association. In this connection he remarked that, although a trades society, it was no part of their business to place themselves in opposition to their employers, but, on the contrary, they wished to prove by their organisation that their services were of increased value owing to the studies they had pursued in order to obtain their certificate. The association was doing a good work, and therefore deserved well of all interested in it. Mr. James Deas, of the Clyde Trust, in moving a vote of thanks to the lecturer, expressed his sympathy with the movement, and believed the time would soon come when an uncertificated man would not be entrusted with the care of an engine. Mr. Turnbull, Mr. Miller, and others also made a few remarks, and a vote of thanks having been passed to the chairman, the meeting separated.

MATERIALS OF ENGINEERING.—VII.

STEEL.

I WILL not attempt a definition of steel just now, but will give an outline of the methods by which "steel" and "ingot iron" are manufactured.

The *single shear* and *double shear* steels are produced by the direct carbonisation of bar iron, by a process termed "conversion," or "cementation." The cementation furnace consists essentially of an oblong chamber of firebrick, occupied by the fireplace, which runs longitudinally down the centre, and by the converting pots ranged on each side. These pots, which may measure 12ft. by 3ft. by 3ft., occupy the whole length of the chamber. They rest upon a network of bearers of brick, among which the flame and hot gases circulate on their way from the fireplace to flues or small chimneys, which lead into a main stack.

Charcoal, the carbonising agent employed, broken into small lumps, is first spread over the bottom of the pots ; upon this is placed a layer of bars, whose cross sections may be about 3in. by ⅝in., and again a layer of charcoal; layers of bars and of charcoal alternating until the troughs are filled. The top layer is always formed of charcoal, and this is covered with the mud from the troughs of the Sheffield grinders, which, being composed of particles of oxidised steel and siliceous matters, fuses and forms an air-tight glazing over the contents of the troughs. Through one end of each pot there is a hole into which a trial bar is inserted, so that by its examination from time to time the progress of the carbonisation of the iron can be observed. The proper temperature is obtained at nearly a white heat, and an exposure of about eight days is required for the production of shear steel.

After the required degree of carbonisation has been obtained, the furnace is allowed to cool down sufficiently for a man to enter and withdraw the bars; when they are sampled according to the different appearances which they present on fracture. Much variation is found to exist in the quality of the bars. The term *blister steel* is applied to them in consequence of their being covered with blisters, ranging from the size of a pea upwards, due to the escape of gases from the interior.

Single shear steel is produced by breaking off or doubling over these bars, and re-heating and welding and drawing them down. Double shear steel results from a repetition of this process, a slight increase in the quantity of carbon, as well as superior homogeneity, resulting from the operation. But steel made by the cementation process is not, and cannot be, thoroughly homogeneous, but is, like malleable iron, apt to be laminated and variable in composition. A truly homogeneous material can only result from fusion and casting. Blister steel, therefore, which has been broken up and re-melted and poured into an ingot, is termed *cast*, or *crucible steel.* The process is not always of this simple character, since bar iron is sometimes melted with carbon, speigeleisen, or black oxide of manganese. Or these are added to the blister steel to impart a required amount of temper and quality thereto.

The steel is melted in crucibles in air furnaces, having much resemblance to brass furnaces. These are termed melting holes, and are arranged in a row along one or more sides of a melting-house. Each furnace has its own chimney, by which the amount of heat is capable of regulation, and the block of chimneys and ashpits open out into a common culvert or vault underneath the floor of the melting-house, in which the attendant arranges the dampers. One end of the melting-house is occupied with annealing ovens, in which the crucibles are gradually heated to redness. The charge for a crucible is from 40lb. to 60lb., and from three to four successive meltings can be made out of a single pot, after which they become burnt and too unsafe for use. The metal is *teemed* or poured from the crucibles into ingot moulds if the quantities of metal are small, but if large they are emptied into a ladle, and thence into the ingot mould or the sand mould, as the case may be; or they are emptied into a runner, which fills the ingot mould.

Formerly all steel was made by conversion, and its employment was therefore very limited. At the present time the older methods, beyond their utility for special purposes, are superseded by the open hearth and Bessemer processes, by which mild homogeneous steel of almost any required grade is obtainable. The making of steel by these methods is a direct chemical process, the metal being first de-carbonised, then re-carbonised, the amount of carbon being literally measured in, in the form of "spiegel" or "ferro." At no time does the steel come in contact with solid fuel. The open hearth furnaces are built on the regenerative principle; the gaseous fuel is produced from bituminous coal, or from inferior materials, and only mingles with the air necessary for combustion when it reaches the hearth of the furnace, which is of the reverberatory type. Previous to this union, the temperature of both gas and air is raised by passing them separately through regenerators. These consist of brick chequering, which in the first place absorb much of the heat from the waste products of combustion as they pass from the furnace hearth to the chimney stack, and which, but for the chequer work, would represent an immense number of heat units wasted. Most of the heat is absorbed therefrom by the regenerators, until after the lapse of from 30min. to 50min., their temperature having been raised sufficiently, the current of escaping gases is reversed and sent through another pair of regenerators, heating them in like manner. Then through the pair already heated the producer gas and the air necessary for its combustion are brought, each through its own regenerator, to the hearth, where combustion takes place. After a while, as the regenerators through which the air and gas are entering become cooled, the direction of the current is again reversed.

The *open hearth* processes embrace the "Siemens-Martin," in which pig iron and scrap iron, or scrap steel, are fused together on the furnace hearth—called therefore the "pig and scrap" process; and secondly, the "Siemens" process, in which pig and scrap and pure iron ores are fused together—hence termed the "pig and ore" process. The latter method is largely employed in England, the former mostly on the Continent. In the Siemens process, about 30 per cent of hematite pig is first introduced into the bed of the furnace, followed by 70 per cent of steel scrap. After this is fused, hematite iron ore is added in small quantities, its function being the decarbonisation of the bath of metal on the hearth, this addition giving rise to the characteristic "boil" which is indicative of oxidation going on. About 26 cwt. of ore will be required for 8 tons of metal. Tests are made from time to time of the chemical and physical conditions of the product. When decarbonisation is finished, the spiegeleisen, or the ferro-manganese, are added, being either introduced into the furnace, or emptied from a bag into the metal as it stands in the ladle. The spiegel and ferro are simply highly manganiferous varieties of iron, definite samples of which, having definite and large percentages of manganese and carbon, afford the best means of adding definite amounts of these elements to the iron which has been decarbonised. It is not necessary to use steel scrap for melting down, but it affords a ready means of utilising waste material.

The Bessemer, like the open hearth processes, is one of decarbonisation and recarbonisation, but there the similarity ceases. The decarbonisation and purification is effected by a strong blast of atmospheric air blown through the molten metal; hence the term "pneumatic process." Recarbonisation is effected by spiegel or ferro, as in the open hearth. Fluidity of the iron is highly necessary; hence the pigs used are certain grey hematites known as "Bessemer pig." White iron, being pasty, does not allow of a free passage for the blowing through of air.

Briefly, the converter is a pear-shaped vessel, made of wrought-iron plates riveted together, and lined to a thickness of from 9in. to 12in. with firebrick and ganister. A trunnion belt encircles the vessel, one trunnion being fitted with spur or worm gearing, moved by hydraulic power, for the purpose of elevating and lowering the mouth of the converter. Through the other trunnion the blast pipe is brought, and passes thence down into the tuyere box underneath the converter bottom. A number of fire-clay tuyeres pass thence through perforations in the bottom lining.

The converter is turned into the horizontal position for charging, the metal being run in either from the cupola, or direct from the blast furnace. The blast is then put on, and the converter turned mouth upwards. In this, the first stage of the "blow," the graphitic carbon passes into the combined form, and the silicon is oxidised to silica. During the boil, which ensues in the course of a few minutes, the carbon becomes oxidised to carbonic oxide, the ebullition characteristic of this charge being very marked, a volume of flame of a deep yellow colour being given off from the surface of the metal. Presently the colour changes and the flame drops, indicating the complete decarbonisation of the metal. The converter is then turned down, the blast shut off, and a certain percentage of spiegel or ferro is then added, its addition being marked by the shooting out of a jet of flame.

Ganister, though highly refractory, and therefore in that respect suitable for the linings of converters, is not *basic;* that is, it is not of a metallic character. The oxidation of phosphorus in the converter with the formation of phosphoric anhydride, or its union with ferrous oxide to form ferrous phosphate, either of which compounds should be expelled with the slags, cannot take place with a ganister lining. The silica, of which the ganister is mainly composed, has so powerful an affinity for ferrous oxide, that it immediately enters into combination therewith, destroying the union, or preventing the formation of ferrous phosphate. The phosphoric anhydride, having no base with which to unite, is then immediately reduced by the carbon at the high temperature of the converter back to phosphorus and oxygen. For this reason, none of the phosphorus which is present in the pig is ever eliminated in the ganister-lined converter. But if a basic lining—*i.e.*, one that is highly metallic—is employed, that has so strong an affinity for phosphoric anhydride, practically the whole of the phosphorus that is present in the iron is removed, passing out into the slags. The material used for lining is dolomite, or magnesian limestone, whose base is magnesia, and lime, the oxide of the metal calcium, is added to the charge. The phosphorus then enters readily into combination with the lime, forming calcic phosphate.

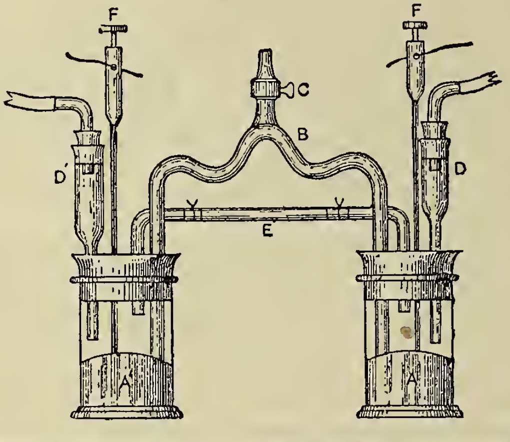
The great commercial value of the discovery of the basic process lies in this, that inferior iron can be used therein. For the original Bessemer, or "acid" process, pure hematite ores, containing 0·1 or less per cent of phosphorus, are required. For the basic process, irons containing 1·0 to 3·0 per cent of phosphorus are employed; in fact, a large percentage becomes a distinct advantage, because by its oxidation it supplies a large number of the heat units necessary to the success of the conversion of the metal. J. H.

ALLOYS: THEIR CONSTITUTION AND PROPERTIES.—III.

(Continued from page 537.)

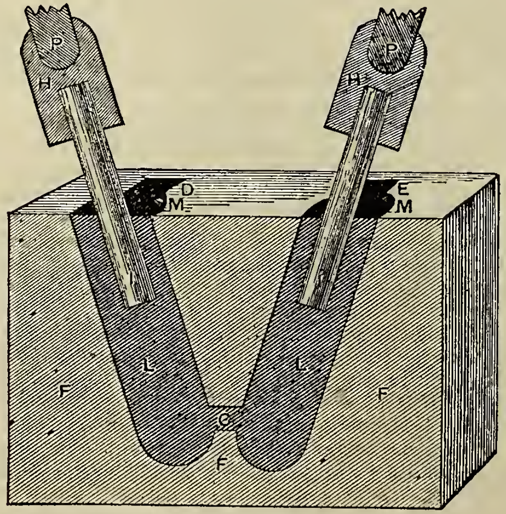
The question now arises, can a well-marked alloy, or a quasi-compound, be in the slightest degree electrolysed by an exceedingly intense electric current? Some experiments conducted by M. Gérardin, in 1861, satisfied him that amalgams of sodium and mercury might be decomposed by an electric current, with partial separation of the constituent metals. The experiments were repeated by Dr. Obach, who employed the apparatus shown in the diagram (fig. 3). The composition of the amalgam was unaltered by the passage of the current. He also used a W-shaped tube containing melted alloys, and proved that no decomposition could be observed after the passage of the current.

FIG. 3.



The sodium amalgam is enclosed in the glass vessels, A A', and metallic communication between them is secured by opening the stop-cock, C, and sucking the amalgam into the bent tube, B. An atmosphere of dry hydrogen is provided by means of the tubes, D D', and the connecting tube, E. The current is transmitted through the amalgam by the battery terminals, F F'. Subsequent examination of the sodium amalgam proved that no separation had been effected by the current.

FIG. 4.



The alloy under examination is enclosed in the cavities, L L', cut in a fire-brick F F F. The cables from the secondary battery, P P, are connected by means of the copper holders, H H, with wrought-iron terminals, I I. The cavities, E M, D M, in the block are arranged so as to enable samples of the molten alloy to be withdrawn from time to time.

Last year, at the request of the Electrolysis Committee of the British Association, I took up the inquiry, and by employing an intense electric current from secondary cells, showed that no separation took place in either certain alloys of lead and gold, or in alloys of lead and silver, even with so strong a current as 300 ampères. The method employed is indicated by the diagram (fig. 4). The experiments are given in detail in the Report of the British Association for last year, and it will be sufficient to say here that as the question at present stands it would seem that fluid alloys conduct just like metals, and not like salt solutions; but as Dr. Lodge has pointed out with reference to these experiments, "if the question as to the possibility of the electrolytic separation of true alloys of metals should be answered in the negative, there must surely remain a group of bodies on the borderland between alloys proper and electrolytes, among which some gradual change from wholly metallic to wholly electrolytic conduction is to be looked for."

In the case of solid alloys—solidified solutions of metals, that is—the nature of the evidence is very different, for the passage of the electric current through solid alloys reveals the existence (1st) of certain well-defined compounds of the metals, and (2nd) affords abundant proof that in certain alloys the metals exist in allotropic states. And here I must go back chronologically, and refer to the classical work of Matthiessen, published in 1860. He showed that the electrical conductivity of all alloys may be graphically represented by one or another of three typical curves, which, as the diagram indicates, are respectively U-shaped (fig. 7), L-shaped (fig. 5), or straight lines (fig. 6). On adding gold to silver, for instance, there is a rapid decrease of conductivity, silver being 100, and the curve gradually turns round and then rises without any break to the point representing the conductivity of gold.

FIG. 5.

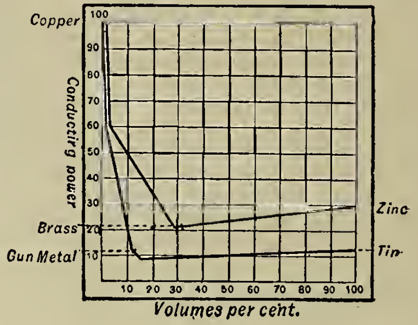


FIG. 6.

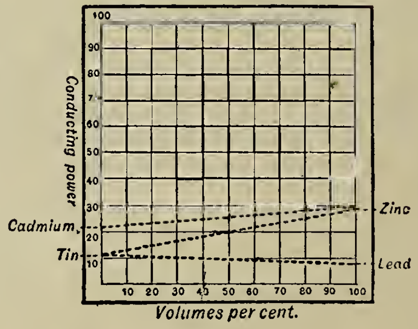
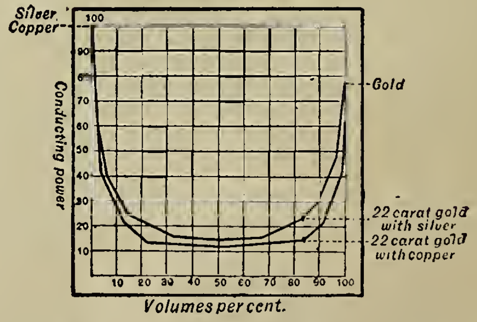


FIG. 7.



In the case of the silver-copper series, silver being 100 and copper 96, there is a marked break in the U-shaped curve (fig. 7) corresponding to the alloy, which contains 71·8 per cent of silver, and this is probably a definite chemical alloy.

In the case of the L-shaped curve (fig. 5), representing the conductivity of the copper alloys $CuSn_3$ and $CuSn_4$ (which contain respectively 61·8 and 68·2 per cent of copper), are probably definite compounds, and a view which is confirmed by Laurie, who has shown quite recently by another method—by determining the electromotive force of the copper—the series that probably $SnCu_3$ is a chemically definite alloy. The nature of the evidence is as follows :—

Mr. Laurie finds that if the zinc plate of a Daniell cell be replaced by a compound plate, formed by joining copper and zinc, the cell has the same electromotive force as one in which zinc alone is used. This is true even though the zinc surface be only $\frac{1}{1000}$th part of the copper surface. If the zinc plate be replaced by copper-zinc alloys, no deflection of the electrometer is observed as long as the alloy contains less than 67 per cent of zinc. At this point, however, a big deflection, practically equivalent to that given by zinc, is suddenly obtained. This result, in his opinion, may be taken as evidence of the existence of a compound of the two metals of the formula $CuZn_2$. Alloys containing a greater proportion of zinc behave like zinc alone. Similarly in the case of tin-copper alloys, a sudden rise of electromotive force is observed when the proportion of tin in the alloy exceeds that which would be contained in a compound of the formula $SnCu_3$. This result is in harmony with the evidence already obtained by observations of the density and thermal and electrical conductivity of the copper-tin alloys. If an alloy containing a larger percentage of tin than $SnCu_3$, in a state of fine division, be placed in a copper cup, and used in place of the zinc in a cuprous chloride cell, the excess of tin is gradually eaten out, leaving approximately the alloy $SnCu_3$. This alloy undergoes no change if the circuit be kept closed.

Of all the researches made by Matthiessen, nearly thirty years ago, none are of more interest at the present than those which enabled him to obtain evidence as to the existence of metals in different allotropic states in alloys.

Turn, for instance, to the tin-copper curve ; he points out that the decrement in the conductivity produced by the addition of a minute quantity of tin to copper is very rapid, and he urges that the amount of tin is far too small to permit the belief to be entertained that true chemical combinations had been formed, and by such reasoning he was led to his great generalisation, that metals may sustain change in their molecular condition by union with each other in a fused state. I hope to show that this may be true, even when a "trace" of one metal is added to a molten mass, but the question of allotropy in metals and alloys must be left for the next lecture.

(To be continued.)

THE MECHANICS OF THE INJECTOR.[*]

THE fact that the injector wastes no heat except a small amount by radiation is usually accepted as proving that the instrument has a very high efficiency ; when, however, we make a careful comparison of it with a good steam pump, we may be surprised to have the latter come out the best. I desire to call your attention to a mechanical principle upon which the injector works, and to show that it is an unfavourable one, and one which accounts largely for the difference in favour of the steam pump.

If a mass of clay or putty be projected against an equal mass at rest, it will set it in motion, and the two united masses will move on with half the velocity given to the first mass ; if, however, the projected mass contains but one tenth, instead of one-half of the whole amount, the final velocity will be but a tenth of that of projection.

The principle governing such cases is called in mechanics the *conservation of the motion of the centre of gravity*, which means that the velocity of the centre of gravity of the united masses is the same as the velocity of their centre of gravity before they united.

In the first instance, the two masses being equal, their centre of gravity lies always midway between them, and therefore moves along with half the velocity of the projected mass ; after impact the centre of gravity is in the centre of the united mass, and as the *impact does not alter its velocity—i.e.*, the velocity of its centre of gravity—we know at once what velocity the united mass must have. In the second case, one-tenth of the mass being in the striking and nine-tenths in the struck mass, the centre of gravity will lie nearest the latter and at a distance from it equal to one-tenth of the distance separating the two masses. The velocity of the centre of gravity will therefore be one-tenth of the velocity of projection, and consequently the masses after uniting will have a velocity of one-tenth of that of projection.

In both these cases, supposing the first mass to be m_1, and the second to be m_2, representing the velocity of the first mass by v, and that of the centre of gravity by V, we find that before impact the energy is $\frac{1}{2} m_1 v^2$, while after impact it is only $\frac{1}{2} (m_1 + m) V^2$. In the first case, $m_1 = m_2$ and $V = \frac{1}{2} v$, so that half the energy disappears at impact, being converted into heat by the blow, and lost. In the second case, $m_1 + m_2 =$ ten times m_1, and V is only one-tenth of v ; consequently the energy after the impact is but one-tenth of what it was before, or nine-tenths is lost by the blow.

Looking more closely into the condition before impact, we see that the energy consists then of two parts, viz., the energy of the whole system of two masses moving with the velocity V and the energy with which the two masses approach each other ; that is to say, we may calculate the energy on the principle that the pair of masses are moving forward with the velocity V of their centre of gravity, and then that mass one has an additional forward velocity $= V$ in the first case, and $9\ V$ in the second, while mass two has an additional backward velocity $= V$ in both cases, thus causing the latter mass to stand still and make the velocity of the first mass $= v$.

Having made this division of the energy, we find, as might be expected, that only the first part of the energy is preserved, while the energy of approach is lost by the blow ; and this holds for all bodies which are not sufficiently elastic to separate again after the blow is struck.

Now, in the injector, the water is almost at rest when it is struck by steam moving with a high velocity, and thus set in motion. If the steam is, say, one-fifteenth of the water, the velocity of the mixture will be but one-sixteenth of that of the steam, and fifteen-sixteenths of the mechanical energy of the moving steam will be lost by the blow. This mechanical energy has been developed by allowing the steam to flow from the boiler into the vacuum chamber, and thus to get up a high velocity ; but, however economical such a method of generating mechanical power from steam may be, it is neutralised by the wasteful way of using the power, for impact is, as has been shown, a wasteful method. In this respect the injector is like a slowly moving impact waterwheel, where almost all of the kinetic energy acquired by the water in running down to the wheel may be lost in heat when the water strikes and dashes into foam ; and yet in such a wheel, were it desirable to warm the water, it might be claimed that no energy was lost.

In the injector a greater part of the energy even than calculated is lost by the blow, from the fact that it is not struck exactly in the direction in which the water is to move.

In reasoning upon the efficiency of the injector, it is not enough to state that no heat is wasted, because there would be none wasted if the steam were condensed into a tank of water for the purpose of heating it, while if our object were to get mechanical power it would all be wasted, whereas in a proper engine we might get out of it the legitimate amount of power. The steam used by the injector is at boiler temperature, whereas the heat when returned is at feed-water temperature, and we should therefore charge against the injector the amount of power which a good engine working between these temperatures would develop, and not credit it with heating the feed-water, except so far as we might not be able to do it with exhaust steam.

COCOANUT FIBRE AS A DEFENSIVE WAR MATERIAL.—In the last report of the curator of the Nilgiri gardens, attention is drawn to a new use for the refuse fibre of cocoanuts. Dr. Lawson says that his attention was drawn to the subject by Mr. Money, a planter in the Nilgiris, who sent him an article in the *Revue des deux Mondes*, in which the author described how the refuse of cocoanut, after the process of retting, might be used for backing the iron plates of ships of war. The method of proceeding was to take a quantity of the powdered refuse before it was quite dry, and subject it to pressure, when the natural viscidity of the macerated cellular substance of the nut caused the whole to cohere and to form a plate which in general appearance was like a mill board, only much more brittle. Owing to the hygroscopicity of this substance, if a hole is made through it, the parts adjacent to the puncture absorb water, swell up, and immediately close the orifice. Dr. Lawson got a sack of this refuse and made a plate 18in. square, by about ¾in. in thickness, which he placed between two boards, and then fastened it to one side of a box, which contained a head of one foot of water. A bullet half an inch in diameter was fired through it, but not a drop oozed out. This experiment was repeated three times with the same result. Then a ¾in. bullet was fired through the plate, when a few drops only made their way through. Lastly, a bullet nearly 1in. in diameter was fired through the plate, when a large jet of water shot through, but in the course of a few seconds the stream decreased in volume, and in less than a minute had ceased to flow altogether. "Whether or not this material could be advantageously used for the purpose suggested, or for any other purpose, is a matter worth considering, for, as he truly says in his article, millions of tons float away annually down our rivers in India."

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[*] Paper read at the Scranton Meeting of the American Society of Mechanical Engineers, October, 1888, by J. Burkitt Webb.

THE BENHAM HYDRAULIC MOTOR.

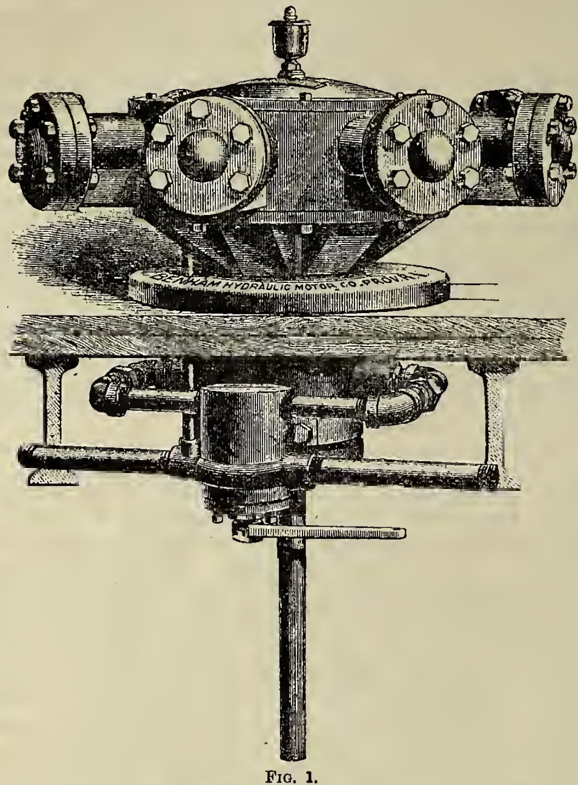

BENHAM HYDRAULIC MOTOR CO. PROV.

Fig. 1.

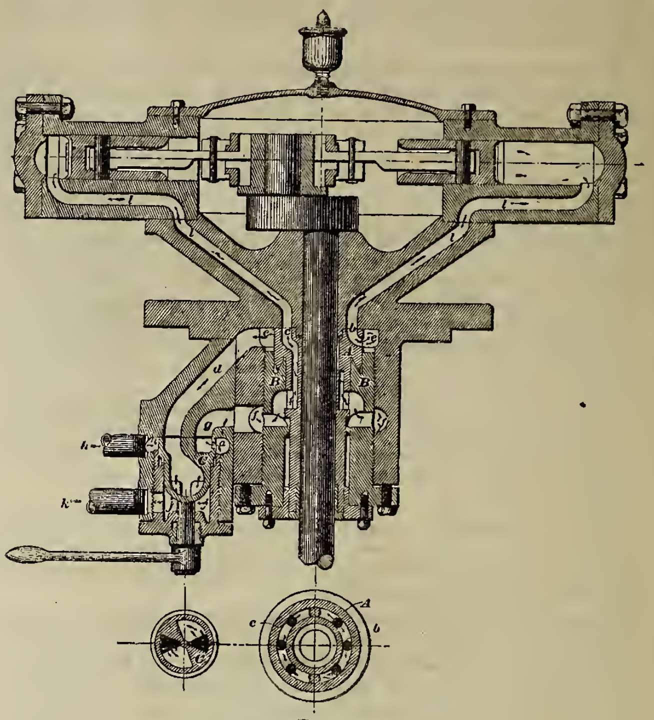


Fig. 2.

THE accompanying illustrations, for which we are indebted to the *American Machinist,* show the general appearance and construction of the water motor now being introduced by the Benham Hydraulic Motor Co., of Providence, R.I.

The motor consists of eight cylinders, arranged in a fixed position, radiating from a common centre, the pistons of which are connected to a common crank pin.

The flow of water to and from the eight cylinders (which are single acting) is controlled by a single brass valve A (fig. 2), which is cylindrical in form, and encircles the main crank shaft, being driven by a feather key in such a manner as to allow of sufficient end movement of the valve to enable the pressure of the entering water to keep it snugly against its seat, and prevent leakage; the surfaces of the valve on which the water pressure can act being so arranged and proportioned as to leave just sufficient unbalanced pressure to accomplish this purpose. The valve has a bearing in the nut B, which assists in keeping it in such a position as insures an even bearing and equal wear upon the valve seat.

The valve seat is provided with eight circular ports arranged in a circle, accurately spaced, and each communicating with its corresponding cylinder by means of the passages *l l.*

The water enters the engine through the passage *d*, and goes into the chamber *e*, around the front end of the valve, from whence it passes through an opening into the annular groove *b* formed in the valve.

From here it passes through the ports covered by said groove at any given time. The exhaust water passes out through the open end of the valve *c* into the chamber and out through the passage *g*.

The motion of the engine is reversed by means of the reversing valve *c*. The water entering this valve through the pipe *h*, enters the chamber *a* around the front end of the valve, and thence into the passage *d* to the main valve. The exhaust water passing through the open end of the reversing valve into the chamber *j*, passes out through the pipe *k*. The reversing valve can be turned one-quarter the way round by means of the lever, which allows the water to enter the passage *g*, and travel the reverse from above stated, thus causing the crank shaft to revolve in the other direction. This latter condition of affairs is indicated by the arrows in the sectional view, fig. 2.

The cylinders being single acting, and open at the inner ends, piston rods are not used, but the connecting rods are attached directly to the pistons.

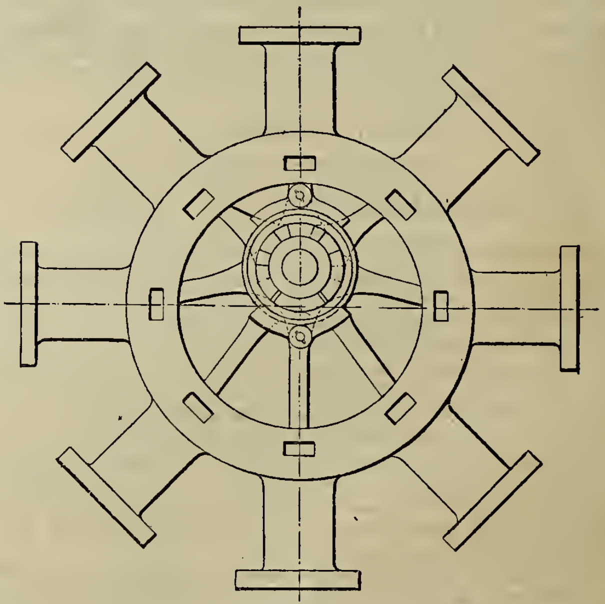


Fig. 3.

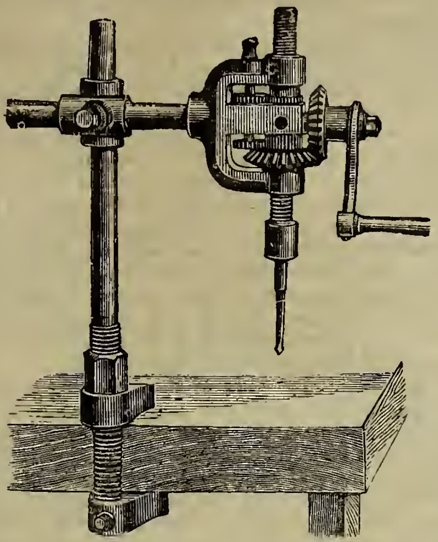
The manner of making the connections is shown in fig. 3. They are made of wrought iron, and at the crank end have a flange turned up at one side and shaped to bear against a steel sleeve, lined with brass, which encircles the crank pin. Four of these flanges are turned one way and four the other, and they are thus enabled to overlap each other on the sleeve, and ample bearing surface is secured. Outside of the flanges two steel rings are put on, which encircle them, one on each side. These rings are held by segments and bolts, and serve to keep all the connections in proper position.

The central space, in which the crank and connections work, is kept filled with oil, so that thorough lubrication and consequent durability is assured.

These machines are suitable for any purpose for which water or other small motors are employed, and can be set with the crank shaft horizontal, or vertical, as shown in fig. 1. They will start in either direction, from any position, the multiplicity of cylinders making three of them always available for starting.

HAND DRILLING MACHINE.

The accompanying illustration represents a patent self-feeding hand-power drill, made by Messrs. T. and R. Lees, of Hollinwood, near Manchester, which possesses several features of special merit. The machine is intended to supplant the old ratchet brace, and is specially adapted for drilling by hand in awkward corners where the work cannot be accomplished with an ordinary drilling machine. The feed-motion is self-acting, and is arranged so that it can be instantaneously detached so as to permit of the drill being lowered to or raised from its work with ease and rapidity. The driving arrangement can be adjusted so as to permit of the handle being turned either in the position shown in the engraving or at right angles to this, and either on the right or left hand of the headstock as may be convenient. The drill is capable of perforating a ¾in. hole 6in. deep, the rate of progression being as near as possible one inch in five minutes, with sixty revolutions of the handle per minute. The fact that the firm have in a comparatively short time sold upwards of 1,300 of their useful little tools speaks well for its efficiency and the favour with which it is regarded.



THE UNIVALVE PLUNGER-PUMP.*

It is known that at speeds above a certain limit the delivery valves of reciprocating pumps remain always open, so that they become useless, and might be suppressed. The univalve pump, as its designation implies, works with a single valve, for the suction only. Whilst an ordinary pump supplies, at each turn of the crank, a volume of water sensibly equal to the volume described by the piston, the discharge of the univalve pump may be one and a half times, twice, or two and a half times the volume of the pump, or more. When the plunger passes the position of half-stroke inwards, where its velocity is a maximum, the ascending column of water being also at its maximum speed, the velocity of the piston gradually diminishes; but the column of water continues to ascend, independently of the movement of the piston, and draws water after it by suction, as if it were a solid piston. The ascending movement of the column quickly ceases, but it has lasted a certain time, which is longer as the velocities are higher, according to the equation of gravity, $v = g\,t$, in which v is the speed, g is gravity, 32·2, and t is the time ascending. The author evolves an equation showing the relations of the speed and discharge,

$$D = (\pi l + 1)\frac{V}{2}n\,;$$

in which D is the volume discharged per second; l the time of making one turn of the crank; V the volume described by the piston for one turn of the crank; n the number of turns per second.

An experimental univalve pump, having the piston of 2·21in. in diameter, with a stroke of 1·57in., was placed at a level of 24in. above that of the water to be raised. The delivery pipe was 1·37in. in diameter, and 11½ft. high. The piston was driven by means of a connecting rod and crank. To start the pump, the delivery pipe was filled with water to a depth of 18in., in order that the plunger might be completely submerged. The suction pipe remained full of air. The pump was started and worked by hand at the rate of from 230 to 240 turns per minute; and at the end of a few seconds the water poured in abundance from the upper end of the delivery pipe. To measure the rate of delivery, the pump was worked at a speed of from 280 to 300 turns per minute; the water was sucked as before from a depth of 24in., and was delivered at a height of 13ft. into a tank of 30 gallons capacity. The tank was filled in 110 seconds, showing a discharge at the rate of 0·273 gallons per second, or 98·4 gallons per hour; whereas the volume described by the plunger was only at the rate of 40 gallons per hour; showing that the actual delivery was 2·46 times greater than the displacement of the pump. The suction valve worked without shock.

The univalve pump takes a place between the centrifugal pump and the ordinary reciprocating pump; but its capability of working under high lifts, as well as under low lifts, gives it an advantage over the centrifugal pump.

BRAKE TRIALS OF ENGINES.

Through the courtesy of Mr. E. Clark, secretary to the Royal Agricultural Society, we have been favoured with advanced proofs of a memorandum which has been prepared by William Anderson, M.Inst.C.E., regarding the engine trials conducted by the society at Newcastle last year. It will be remembered that considerable dissatisfaction was expressed by some of the exhibitors at the method in which these trials were conducted, and with the results that were deduced from them. As the paper discusses several interesting points in connection with engine trials generally, it will doubtless be of considerable interest to a large number of our readers, and we therefore reproduce it in full. The memorandum is as follows:—

Memorandum on the Newcastle Engine Trials. By William Anderson, M.Inst.C.E., Consulting Engineer to the Society.

There are several matters connected with the engine trials at Newcastle in July, 1887, and the deductions made from them, which it will be beneficial to review.

Exception has been taken to the mode adopted, in the engineers' report, of reducing to a standard temperature and pressure the quantity of water evaporated by the boilers. It has been pointed out that instead of assuming the water to have been actually evaporated at 212 deg., as has been done, the larger quantity of heat at the working pressure should have been allowed for. Thus, in the case cited of engine No. 3,114, the steam in the boiler was at 120lb. pressure, equal to 350 deg. temperature, and each pound contained 1188·75 units of heat above the freezing point. The water was pumped in at 83·6 deg., or 51·6 deg. above 32 deg.; hence the number of units per 1lb. of steam was 1137·1, and not 1095 as stated in the report; and the quantity of water evaporated should have been estimated at nearly 4 per cent higher. The correction, if made, will not sensibly affect the comparative results, and it should be understood that neither method of reduction will give even an approximation to what a boiler working at some given pressure would do if worked at that of the atmosphere. The rate of evaporation in a boiler depends not only upon the quantity of heat which has to be imparted to the contents of the boiler, but also upon the difference of temperature between the products of combustion in the furnace and flues, and the water in the boiler. The lower the pressure the greater this difference becomes; but as we have no means of measuring the mean temperature of the furnace and of the products of combustion, we cannot tell what the difference of temperature may be, and therefore one of the factors in the calculation is missing.

It is difficult also, if not impossible, to arrive at any conclusion by direct experiment, because, in boilers such as those generally used in agricultural engines and in locomotives, the mass of water and the free surface from which the steam can escape are small compared with the volume of steam generated. At high pressures these volumes are reduced in proportion to the presure; thus at 120lb. per square inch each bubble of steam would be one-ninth the size of the same weight of steam at atmospheric pressure. Hence ebullition in the latter case is much more violent, and the consequent priming of the boilers more severe.

In some recent experiments with an eight-horse boiler, I found that the boiler could not be worked at a lower pressure than 35lb.

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* Foreign Abstracts. Proc. Inst. C.E.

to the square inch, because water was so abundantly ejected with the steam. At 98lb. pressure 5·85lb. of water were evaporated from 49 deg. by 1lb. of inferior coal, while at 35¾lb. pressure, 6·48lb. were evaporated from 47½ deg., or nearly the same temperature. The units of heat imparted per 1lb. of steam were only as 1167·5 is to 1152·3, and the evaporation at the lower pressure should only have been 5·94lb. of water per 1lb. of coal, instead of the quantity given above. The excess, amounting to 9 per cent, was due probably to the increased difference of 55 deg. between the temperature of the water in the boiler and the furnace, and no doubt also to some extent to priming.

The method of ascertaining the rate of cooling was not satisfactory. It was impossible to seal the ashpans and the firebox and smokebox doors completely, so as to prevent all access of cold air to the inside of the boiler; and the conditions during cooling were not the same as when the engines were at work, for the observations commenced generally in the evening when the weather was colder, and the runs took place in a covered shed, while the cooling proceeded in the open air.

In future efficient means of closing the chimney should be provided, and the sheds should be made roomy enough to allow the engines to cool in the same place where they worked.

With respect to the general conduct of the trials, it would be well that on a future occasion there should be two weighing machines appropriated to each engine. One should be fitted with a coalbox large enough to hold the whole of the coal required for the trial run, and should be so arranged that the driver could fire direct from it; and the second machine should be fitted with a water tank capacious enough to hold the whole quantity of water likely to be used. The weight of coal and water should be taken every ten or fifteen minutes, so that the rate of consumption throughout the run might be ascertained, and all chance of error avoided. It may, indeed, be necessary in some cases—when, for example, the condensed steam from the feed heaters is returned to the feed tanks—to use two small supplementary tanks and weighing machines besides the main feed tank, in order to gauge correctly the quantity of water evaporated.

It is desirable to alter the revolution counters on the brakes, so that the figures should appear clearly on the revolving dials, in order that the number of revolutions may be easily read off while the counters are running; and this reading should be taken simultaneously with the observation on the weight of coal and water. By taking these precautions, a run will not be lost in the event of some temporary mishap in the trial, a circumstance which often occurs.

In future, a good clock with a seconds hand should be fixed in a conspicuous position, and should be the standard of reference for time. Hitherto the watches of the judges and engineers have been used, but considerable confusion has more than once arisen when a judge has not been able to see a trial run through. He has had either to hand his watch over to his colleague, or to get the watch of the latter set to his own.

With respect to the employment of automatic recording instruments, about which many suggestions have been offered, I do not think that they are applicable to the wants of the society. In the first place, the time allowed for the trials is necessarily short, and it would therefore be difficult to fix and adjust the apparatus; but the chief objection is, that it is impossible to find out from the exhibitors, in reasonable time, what their engines will be like.

Many of the engines are not even designed at the time of entry, and are not completed till a very few days before the trials; the speeds and brake horse-power are not fixed, and even such a simple matter as the indicator gear is not properly prepared. Thus, at the last trial, one engine had indicator cocks and pipes so small that the diagrams were worthless; in two other engines the gear had to be altered, and these same engines ran in a direction contrary to all the others, so that a spare brake, provided for such a contingency, had to be altered on the spot for their special benefit.

It might perhaps be instructive, after the competition is over, to run the prize engines a second time, and make observations which could not be undertaken during the competitive runs; but it is doubtful whether the exhibitors would like any such proceeding, as it would prevent the engines appearing at once on the stands.

There has been a good deal of controversy in the engineering papers respecting the action of the society's brakes, fitted with Appold's automatic adjusting levers.

It appears that both Mr. Appold and Mr. C. E. Amos were aware of the effect which the pull upon the upper end of the adjusting levers has on the power developed on the brake; they do not seem, however, to have attached any importance to it, or to have made any corrections in respect of such error in the trials recorded in the society's journal. The late Mr. Rich, who conducted most of the experiments after the retirement of Mr. Amos, was well aware of the possible source of inaccuracy, but he was of opinion that it was insignificant, or, at all events, not serious enough to affect the comparative results, which it was the main object of the trials to obtain.

The point was not lost sight of when it became necessary to decide upon the mode of conducting the Newcastle trials. It was considered important that those trials should be carried out as nearly as possible in the same manner as those at Cardiff, and with the same instruments, in order that a comparison might be made which would indicate the advantages, or otherwise, of the compound system.

It might be argued that if the sources of error were known, arrangements might have been made for measuring the pull on the ends of the adjusting levers, and obtaining in that way the means of making corrections, if any were required. But any such attempt would have involved an important change in the brakes; that is to say, the points of suspension of the levers would have had to be made movable instead of fixed, and the brakes would consequently not have been the same as those used at Cardiff. The importance of precise similarity is, in the eyes of the competitors, very great, a fact which is illustrated by the circumstance that Messrs. McLaren were not content to be tried on a brake exactly similar to that assigned to Messrs. Davey, Paxman, and Co., but they wished to be run upon the very same instrument. Had time permitted, I should certainly have preferred to run all the engines on the same brake.

The pull upon the upper ends of the adjusting levers depends upon two things: first, upon the load suspended to the brake strap; and secondly, upon the mode of lubrication of the strap and wheel, because upon this depends the tightness of the strap.

With a given weight of strap, and up to a certain tension, the amount of which depends upon the mode of lubrication, the strap does not come into actual contact with the whole circumference of the brake wheel. There is no appreciable variation of stress at the points of attachment of the brake strap to the adjusting levers in consequence of variations in the load; the brake strap does not press against the lower half of the wheel at all, and hence the levers are inoperative, that is to say, the swing of the lower ends will not alter the tightness of the strap, and there is consequently no pressure at their fixed ends caused by the load. When the lubrication is very good, and the coefficient of friction is consequently small, the brake strap has to be tighter than when the lubrication is inferior and the coefficient of friction large, and the pressure on the fixed ends of the adjusting levers increases in proportion.

As soon as the strap begins to bear all round the wheel, the pull on the upper ends of the adjusting levers begins to increase proportionately to the load added. This pull will have the effect of reducing the amount of the load on the brake by the amount of such pull reduced, in the ratio of the distance of the fixed ends of the levers from the centre of the brake shaft to the distance of the point of suspension of the load from the same place.

I am indebted to my partner, Mr. Wm. Dickinson, for the following investigation into the theory of the brakes:—

Let W = load on brake strap.
„ $T_1 T_4$ = tensions just above and below the points of suspension of W,
„ $T_2 T_3$ = tensions at two ends C and D of strap connected to lower ends of compensating levers.
„ P = pull on upper ends of these levers.
„ a, a' = radii of brake strap and wheel respectively.
„ $OD = d$, $CD = b$, and $OE = c$.
„ F_1 = friction of ABC.
„ F_2 = Friction of AD, and F = total friction of brake strap.

The portion ABC of the brake strap is kept in equilibrium by the tensions T_1 and T_2 at its ends, the friction exerted on it by the wheel and by its own weight. This gives, taking moments about O—

$$T_1 a = T_2 \mathrm{OM} + F_1 a' + \text{moment of weight of ABC.}$$

Considering the portions AD in the same way,

$$T_3 \mathrm{ON} = T_4 a + F_2 a' - \text{moment of weight of AD.}$$

Adding these two equations, we get

$$T_1 a + T_3 \mathrm{ON} = T_2 \mathrm{OM} + T_4 a + (F_1 + F_2) a' + \text{difference of moments of weights ABC and AD.}$$

But the moment of weight of ABC = moment of weight of AD because the strap is accurately balanced.

$$\therefore (T_1 - T_4) a = T_2 \mathrm{OM} - T_3 \mathrm{ON} + F a'.$$

$$\text{Now } \mathrm{OM} = \mathrm{OC} \text{ sine } \mathrm{OCM} = (d - b) \text{ sine } \mathrm{OCM}$$

$$\text{and } \mathrm{ON} = \mathrm{OD} \text{ sine } \mathrm{ODN} = d \text{ sine } \mathrm{ODN}$$

$$\text{and } T_1 - T_4 = W.$$

Substituting these values in the above equation, we get

$$W a = T_2 (d - b) \text{ sine } \mathrm{OCM} - T_3 d \text{ sine } \mathrm{ODN} + F a'$$

$$= d [T_2 \text{ sine } \mathrm{OCM} - T_3 \text{ sine } \mathrm{ODN}] - b T_2 \text{ sine } \mathrm{OCM} + F a'.$$

But, because the lever is in equilibrium, considering the forces at right angles to it,

$$T_2 \text{ sine OCM} = P + T_3 \text{ sine ODN}$$
$$\text{or } P = T_2 \text{ sine OCM} - T_3 \text{ sine ODN};$$

And by taking moments about D of all the forces acting on the levers,

$$\text{DE} \times P = \text{CD sine OCM}.\ T_2$$
$$\text{or } (d - c)\,P = bT_2 \text{ sine OCM}.$$

Substituting these two relations in the above equation, we get

$$Wa = dP - (d - c)\,P + Fa'$$
$$Wa = cP + Fa'$$
$$\text{or } W - \frac{c}{a}P = \frac{a'}{a}F.$$

That is to say, in order to get the effective value of W, the pull at E diminished in the ratio of c to a must be deducted.

This result agrees with the principle that the external forces acting on the system should balance. Since it is at rest and the tensions are internal forces, *the load*, *the pull* at E, and *the friction* are the only external forces that have to be considered, as the point of support is in the centre of gravity of the strap.

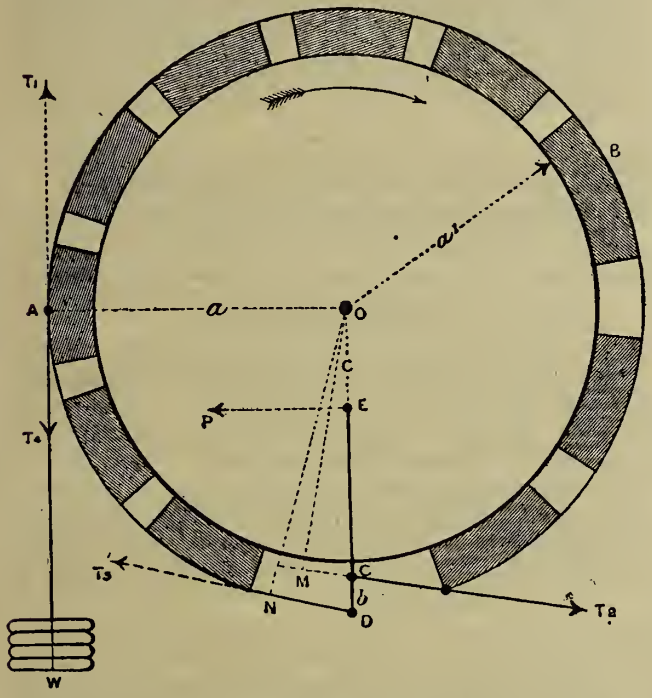
This gives, at once, by taking moments about O,

$$aW = cP + Fa'$$

as before. Also because

$$P = \frac{bT_2 \text{ sine OCM}}{d - c}$$

it follows that P depends upon the tension of the strap and upon the proportion which CD bears to the whole length of the lever. Now, the tension of the strap depends upon the lubrication; hence the more efficient that is, the greater will be the inaccuracy of the brake.



It is evident that, in order to determine the probable amount of error in the Cardiff and Newcastle trials, the pull upon the upper ends of the levers must be ascertained when the brakes are running under exactly the same conditions as to power, speed, temperature of air, and lubrication. It would be impossible to secure all these conditions, and I have consequently made no attempt to repeat the trials. I have, however, satisfied myself by experiment that when the lubrication is constant, the pull on the upper ends of the levers always bears a constant ratio to the load on the brake.

The amount of error due to the Appold arrangement is, I believe, not great for moderate powers, and Messrs. McLaren have given me the means of verifying this opinion. Feeling dissatisfied with the results obtained at Newcastle, they requested Mr. Halpin and Professor Barr to repeat the trials with their compound engine, and for this purpose they used two brakes, one designed by Mr. Halpin, and the other constructed on the same principle as those used by the Society. Messrs. Halpin and Barr's report was published in the *Engineer* of December 2, 1887, and indicates that considerable pains were taken to make the trials as accurate as possible.

The following table gives the results obtained by Messrs. McLaren, and at the Newcastle trials of the society.

It will be seen that the figures agree very closely; hence we are bound to assume that the experiments at Newcastle were substantially accurate, or that Messrs. Halpin and Barr have erred to the same extent as we are supposed to have done.

	Messrs. McLaren's Trial.		R. A. S. E. Trial.
	Halpin's Brake.	Brake made like R. A. S E.	
Indicated Horse Power	23·7	22·2	24·02
Brake Horse Power	20·2	19·1	20·77
Coal per Brake H.P. per hour	2·11	2·14	2·267
Water supplied per Brake H.P. per hour.	22·1	22	21·53
Mechanical Efficiency	·85	·86	·86

Nevertheless, as there is an undoubted source of error in the society's brakes, I recommend that in future trials the Appold levers be dispensed with, or some other form of measuring instrument be adopted. Improvements in instruments devised for measuring power are going on constantly, and it would therefore be unwise to fix on any particular form till the necessity for making a selection arises.

THE SNYDER EXPLOSIVE SHELL.

There appears to be no limit to the development of man's ingenuity in devising schemes for the destruction of his fellows. We are informed that Mr. H. F. Snyder, of New York, has succeeded in constructing a projectile by means of which it is possible to fire from an ordinary gun shells filled with explosives of the most active character. The difficulty in the way of doing this has been that the charge was liable to be ignited by the shock of the powder explosion against the base of the shell, so that the latter would burst in the calibre of the gun; but Mr. Snyder has overcome this difficulty by the expedient of introducing a buffer of indiarubber between the powder and the base of the shell, so that the latter receives a push instead of the ordinary concussion.

The projectile, as now made by Mr. Snyder, consists of two portions—the front, or actual shell, which contains the charge of dynamite or of nitro-glycerine, and a detachable posterior portion which contains the buffer. Taking the projectile for a 6in. howitzer as an example, the front part, which contains the dynamite, is of the common cylindrico-conoidal form, and is about two and a half diameters in length. It has a solid dase, is charged by removing a screw plug from the apex, and its posterior half is turned down so as to be of slightly smaller external diameter than the anterior half.

For experimental purposes the material is brass, but steel would be used in actual warfare. The posterior or detachable half of the projectile is a tube of soft brass about 9in. in length, which accurately fits the bore of the gun, and which receives the actual shell in front. The base of this tube is closed by metal, and its posterior 7in. are occupied by a plug of indiarubber, which fits into its interior. This plug is fluted externally, and contains several cylindrical cavities or air chambers, open at the back and closed in front. The plug being pushed home in the hinder portion of the tube, leaving the front 2in. free, the charged shell is pushed in to occupy this space of 2in., and then the projectile as a whole is ready to be placed in the gun in front of an ordinary powder charge. When the gun is fired, the first effect of the powder is expended upon the indiarubber and upon the air contained in its chambers, with the effect that the plug and the tube containing it are compressed, shortened, and forced into the grooves of the rifling. No shock is imparted to the dynamite, and the projectile as a whole is gently started on its way, the explosive contents not being fired until the shell strikes against the object towards which it is directed, when an effect is produced determined by the quantity and properties of the charge.

Mr. Snyder's first experiments were made with quite small shells, but, finding them completely successful, he became emboldened to try larger and larger guns and charges, and he has now repeatedly fired 8lb. or 10lb. of dynamite or nitro-glycerine from a 6in. howitzer. He came to Europe intending to place his inventions at the disposal of the English Government, but his shells and gun were seized at Liverpool by the Custom authorities, and he finds that the laws in force here with regard to the use of explosives are practically prohibitory of the loading processes which it would be necessary for him to carry out. In consequence of these obstacles he went on to Turkey, where he was very cordially received, and had many opportunities of firing at fixed targets with, if the testimony of photography is conclusive, most destructive effects. He is also negotiating with the Austrian and Italian Governments for experiments in their respective countries. In addition to the power of firing explosives with safety, Mr. Snyder claims that his system greatly diminishes recoil and also the strain of the powder charge upon the fabric of the gun.

CORRESPONDENCE.

We do not hold ourselves responsible for the opinions of our Correspondents.

PATENTS FOR INVENTIONS.

To the Editor of "The Practical Engineer."

Sir,—As one feeling strongly on the question of the formation of a "closed" profession of patent agents, kindly allow me to prevent Mr. Chapman's letter in your last issue going without a word from the other side. I may premise my remarks by stating that, with Mr. Chapman, I read your admirable paper regularly, and find a large amount of instructive matter, evidently original, which is of great service to me as an engineer, and occasional patent agent, and I am particularly pleased to hear that the size of your paper is to be increased, even with the addition of another penny to its price. Mr. Chapman, in his second paragraph, speaks of the "intention" of the bill to be introduced. No one, I suppose, will charge the promoters of this bill with other than good *intentions*, but they must admit that their intentions may not be fulfilled, and on this point outsiders are quite as capable of judging as they.

As regards the objections raised to the excerpts from your leading article, as set forth in the third paragraph of Mr. Chapman's letter, I should perhaps leave that with you, but I think it as well to point out that he appears to me to purposely misconstrue the meaning and application of the first quotation, and couples the second with such words of his own as to entirely alter the meaning in the original.

The latter part of the third paragraph I quite agree with, but the fourth paragraph appears very misleading. It reads as though the new bill will keep the sharpers or rogues outside the profession, when, as a matter of fact, they will be the first to claim and obtain admission; for even Mr. Chapman will admit that a remarkably large proportion of those agents who can prove being in practice before July 1st, 1887, can come under no other classification than that he makes. And herein his admitted want of knowledge of the acts referring to solicitors, doctors, dentists, and veterinary surgeons stands him in good stead, for if he called to mind that admittance to these professions is only to be gained after showing by *examination* a proper acquaintance with the knowledge required, he would see that the new Patent Act is lacking in the most important particular, viz., the necessity for an agent to prove his fitness to be admitted to a closed profession before he is allowed to enter. The mere fact of an agent having been in practice before a certain date can be no guarantee of his qualifications.

The last two paragraphs are equally open to objection, the fifth being drawn in such a manner as to be nothing more than a *suppressio veri*, as will be seen by reference to your leader.

With regard to the last paragraph, Mr. Chapman should remember that the most noteworthy cases in which patents have been upset before a legal tribunal have been with reference to patents carried through entirely by members at the head of the profession.

Finally, the inuendo in the last two lines of the second paragraph, and the reference to the motto (freely translated as "hear both sides"), appear to me particularly out of place and uncalled for. If Mr. Chapman will re-read your article, he will find the agents' side of the case, in my opinion, very fairly put; indeed, the readiness with which you inserted his letter is, to my mind, good evidence of your desire to be strictly impartial.—Yours, &c., G.

London, Nov. 12th, 1888.

THE ENLARGEMENT OF "THE PRACTICAL ENGINEER."

To the Editor of "The Practical Engineer."

Sir,—It gave me great pleasure to read the article which you addressed to "Our Readers" in last week's issue, and, as one of that numerous class, permit me to say that it is very gratifying to learn that *The Practical Engineer* is well on in the path of prosperity, and I take this opportunity of expressing my thanks for the many additions it has been the means of making to my stock of knowledge since it started, eighteen months ago. There are one or two little defects, however (or at least such I consider them to be), to which, with your permission, I should like to draw your attention, if you would not take it amiss.

In the first place, do you not think that the publisher's announcements, which appear before the leading article, would be better if placed on an advertisement page? The volume would, I think, certainly look better when bound with them left out. Secondly, with regard to Queries and Replies, I am obliged for the answers which have frequently been afforded me through the medium of this column, but think it would be better if the queries were put in alone one week, and the answers allowed to stand over to the next, as it would then give some of your readers an opportunity of coming forward and expressing their opinions.—Trusting I have not trespassed too much on your valuable space, I am, sir, yours, &c., G. B.

[The suggestion of our correspondent with regard to publisher's announcements is a good one, and had it been made to us some months ago we should have been glad to have fallen in with it. Our present arrangements, however, are such as to quite preclude its adoption for some time to come. With regard to queries and replies, we would point out that the majority of our correspondents desire answers as promptly as possible, and in this respect we try, as far as possible, to oblige them. In many instances, however, we are compelled from several causes to hold the queries over, but we are always glad to open our correspondence column for the opinions of our readers upon any subject of current interest. We have received several letters referring in complimentary terms to the proposed enlargement of the next issue of our journal, but press of space prevents our inserting them. We should, therefore, be glad if our correspondents would kindly accept this acknowledgment. We need hardly say that it affords us great pleasure to find the proposed alteration meets with such unanimous approval.—Ed.]

QUERIES AND REPLIES.

Bearings for Heavy Machinery.—Can you inform me whether any other kind of bearings besides the ordinary brass ones are used for heavy machinery?

Answer.—We don't quite understand the drift of your question. If you mean is any other material besides brass used, we may say yes. Babbitt's metal is very often used for lining the bearing parts of engines and machinery which are subject to much friction. Many inferior qualities of this metal are sold, but the proper composition is as follows: 4lb. of copper, 12lb. of Banca tin, 8lb. regulus of antimony, and 12lb. more tin while the mixture is in a molten condition. Pour the antimony into the tin, and mix with the copper in a separate pot off the fire. This is termed the hardening, and the actual lining metal is composed of 1lb. of this mixture to 2lb. of Banca tin, so that the final composition is 4lb. copper, 8lb. regulus of antimony, and 96lb. tin. —Ed.

Bronzing Iron and Steel.—Would some reader of your valuable paper kindly furnish me with a recipe for bronzing iron and steel?—Driver.

Joy's Valve Gear.—I hope the question of "G. H." regarding Joy's valve gear will be fully answered, and if you could accompany the answer with a sketch it would, I think, be of interest to a many of your readers.—Japan.

Incrustation in Surface Condenser's Tubes.—Can any reader inform me how to remove the incrustation from the inside of the tubes of a surface condenser of a land engine? The deposit is very hard and tenacious, and consists almost entirely of carbonate of lime.—Nemo.

Joy's Valve Gear.—Can any of your readers tell me how the valves are set in an engine when Joy's valve motion is adopted? Also, how to get the lead of valve? Suppose a valve to have $\frac{1}{8}$in. lead, and it is desirable to increase it to $\frac{3}{16}$in., how would you operate?—G. H.

Plumbago Crucibles.—I should be obliged if some correspondent would kindly inform me what is the composition which is used in the manufacture of black lead or plumbago crucibles.

Diagram of Stress for Girder.—I should be obliged for any information regarding the most correct method of setting out a parabola for a uniformly-loaded straight girder, supported at both ends, showing line of stress and how to fix length of plate by same. One method I know is to draw the flange plates full size vertically, and make the central vertical line equal to the height thus obtained. But is there not another method of setting up the centre vertical line by taking the areas of the plates and angle irons consecutively?—Gyrtona.

Weighing-Machines.—Is there any book published dealing specially with the construction of these machines, and what is the price?—T. D.

Chilled Furnace Bars.—Can any of your readers give me any information with regard to chilled furnace bars? To what depth can they be chilled from the top surface? Is it difficult to cast chilled bars any length—say 6ft.? What difference does it make in the nature, temperature of fusion, and also cost as compared with ordinary furnace bars?—Durability.

Hoppers for Grinding Mills.—Having a number of hoppers to make for a grinding mill, I shall be obliged if some reader would give me a rule other than rule of thumb for finding the proper bevil to plane the corners to.—A Country Millwright.

Hydraulic Ram.—Can any reader oblige me with a sketch and rules for proportioning a modern hydraulic ram, such, for instance, as the "Galiban" ram? I have studied the description of the hydraulic ram given in Rankine's "Prime Movers," but the sketch there given is very obscure, and I cannot follow the action of the waste water valve.—Querist.

Horse Power of Gas Engine.—Will some reader kindly afford me full information as to how I can obtain the horse power of a gas engine?—G. B.

TO CORRESPONDENTS.

J. T.—We have not a copy of the patent specifications regarding ball bearings by us. Indeed, if we are not mistaken, there are quite a number of patents in connection with this device. In order to ascertain what has been done in this direction, your best course would be to visit some library of patent specifications. There is generally an institution of this kind in most of our large towns.

Jenkinson.—It would appear from your query that your knowledge of turbines is extremely limited. The right of manufacture is not vested in any particular firm. There are numerous makers of these motors all over the country. The data you give in your letter are somewhat meagre, but if we understand you rightly the supply would maintain a 12in. pipe constantly full, and afford a head of 3ft. Such a supply would scarcely, we think, give one horse power.

Birmingham.—The subject of chimney draught is one that has been frequently touched upon in our columns. It is quite true, as you say, that there is great diversity of opinion. This, however, is mainly the result of ignorance, and the remarks of the working foreman you quote is an illustration of this. The interposition of a great length of flue between the boiler and the chimney would not add anything to the draught, but it would certainly increase the frictional resistance to be overcome, and to that extent would be detrimental. The pull of a chimney is measured by the height from the level of the firegrate to the top, and not by the length of flue underground. We note your remarks with regard to the proposed enlargement of our paper, and are pleased to learn that, as a reader, it meets with your approval.

FIREMAN.—We are not aware of the existence of any method by which the smoke tube of a marine boiler could be replaced under steam. There are, of course, several kinds of stoppers, by means of which a leaky tube can be plugged under pressure, and the operation of plugging is frequently performed under steam when tubes give out at sea.

J. SMITH.—The book which would probably best meet your requirements is Professor Jamieson's "Elementary Manual of Steam and the Steam Engine," published by C. Griffin & Co. The price is 3s. 6d. You will find particulars of the book advertised on our front page.

ANXIOUS.—The mean pressure in the cylinder cannot be calculated by slide rule, but must be obtained in the ordinary way, that is, measuring the pressure on the diagrams at a number of points and taking the average. When the mean pressure is obtained, the slide rule is of convenience in estimating the horse power of the engine. The little book you refer to deals specially with Routledge's rule. With regard to your further question respecting friction in pipes, this cannot very well be dealt with without algebra. Taking the specific case you put, however, we may say for your information that, neglecting friction, the pressure tending to force the water into the condenser will be that due to a head of water 34 – 14 = 20ft. in height, say a pressure of nearly 9lb. on the inch. With a 100ft. length of 4in. pipe, however, considerable frictional resistance would be opposed, and the water would only flow with a velocity of about 900ft. per minute, equal to a supply of about 470 gallons per minute. You will perhaps better understand the principles which govern the reply to your question if you will read the letter on pumping water in our issue for August 31st, page 419, as well as a reply to a query on Sept. 14th, page 443. Referring to the last query in your letter, we have not a sketch by us, but think the description given will enable you to apply one. We are pleased to learn that the proposed enlargement of our journal meets with such unanimous approval. Thank you for your kind wishes.

THOS. CARR.—To advise a patentee with regard to the value of his inventions is always a delicate matter, and we certainly could not undertake to perform such service gratis, as the advice, to be of any value, would necessitate a considerable amount of trouble and research. In no case could we undertake to furnish information such as you seek by return of post. We should think your best course would be to consult some engineering friend in whom you have confidence.

MISCELLANEA.

THE ELECTRIC LIGHT AT EASTBOURNE.—The town of Eastbourne is now illuminated with over 1,700 electric lights, and the installation is said to be most satisfactory in every way.

TRIPLE EXPANSION.—The Union Steamship Company are having their boats re-engined. The compound engines are taken out and replaced by triple-expansion engines, constructed by Messrs. John and James Thomson, of Glasgow. The saving in coal in the ten steamers which have been completed varies from 16 to 32 per cent, according to the age and character of the ship at the time of alteration. The average saving on the whole fleet is estimated at about 21 per cent of actual consumption.

THE DISTANCE OF THE SUN.—The results of the American observations of the last transit of Venus, in 1882, have been tabulated and summarised by Professor Harkness. Ten stations of observation had been established in the United States, and 1,472 photographs of the transit had been taken. The mean results give the parallax as 8·847min. ; that is, the mean distance of the earth from the sun is about 92,385,000 statute miles. Professor Newcomb had, twenty years ago, estimated the parallax at 8·848min. ; and the American astronomers estimate the possible error at not more than 130,000 English miles.

A NEW FIBRE.—A manufacturing firm in New York has sent to the United States Department of Agriculture specimens of a new fibre they are making from the stalk of the cotton plant. The samples received strongly resemble hemp, and seem to be adapted to all the uses hemp is put to. A few fibres of it twisted together in the hand show remarkable tensile strength, although no exact comparative tests with other fibres have yet been made. A collection of the fibres of hemp, flax, jute, ramie, &c., from all parts of the world is being made by the department, and a new instrument has been invented by which it is expected that the tensile strength of each will be ascertained with great accuracy.

ELECTRIC SIGNAL LAMPS.—Electric lamps have been used for signals on the Southern Pacific Railroad for about 18 months at Oakland Station, California. The lamps require 1·2 ampere to give 16 candles, but a current of only about ·8 ampere is employed, which greatly increases the life of the lamps, and yet gives a sufficiently powerful light for the signals. Some of the lamps have already been lighted for 2,600 hours, and it is thought that they will last another year. The first cost of the plant is stated to have been low, and there is great economy in the working expenses. The light given is also more satisfactory than was that of the old oil lamps, as the face of the lens is not blackened by soot or smoke, and the light cannot be blown out.

ANTARCTIC EXPLORATION.—It is stated that contracts have been entered into in America for the construction of two steamers intended for an expedition to the Antarctic regions, which is being organised by Mr. Henry Villard. The officers and scientific staff of the expedition will all be Americans and Germans, as the enterprise is stated to be in great part supported by Hamburg money. The expedition will start from New York, and its object will be mainly the exploration of the South Shetlands, South Orkneys, South Georgia, and the Poovel Islands. This expedition seems to be independent of that to be sent out by the German Government under the conduct of Dr. Neumayer.

PARIS EXHIBITION.—Satisfactory progress is being made with the Indian section of the Paris Exhibition, though it is feared that the space will be quite insufficient to meet all the demands. An Oriental palace, the erection of which will cost about £3,000, promises to be a unique feature of the exhibition, and is likely to attract a good deal of attention. At a meeting of the committee, held at the Society of Arts on Saturday last, it was stated that the charge to be made for each stall is £100, and as the number is limited to twenty, independently of the tea department, it is desirable, to prevent disappointment, that intending exhibitors should make early application to the honorary director (Mr. Vincent Robinson).

THE UNION OF LANCASHIRE AND CHESHIRE INSTITUTES. The annual report of the Council of the Union of Lancashire and Cheshire Institutes states that the confederacy now numbers 55 institutes in union, with a membership of over 50,000. Thirty-three of the institutes took part in the competitions of the year, as against 35 last year, and 21 had gained prizes, as against 17 in 1887. The number of students in the evening classes was about 20,000. There had been 1,494 sitters at the examinations, as against 1,268 in the previous year. The commercial examinations were steadily increasing in usefulness from year to year. The council make an urgent appeal for an increase in the private subscription list, as the present small income is inadequate to meet expenses.

RUSTLESS COATING FOR STEEL AND IRON.—The De Méritens method of rendering steel and iron non-rusting, communicated by the author to the International Society of Electricians, is thus described: The layer of oxide on the surface of the metal is obtained by placing the article as an anode in a bath of common or distilled water. The sides of the vessel holding the liquid, or a piece of iron, copper, or carbon, are used as cathode. The temperature of the water is kept at 160 deg. to 170 deg. Fahr. The electro-motive force must be just strong enough to decompose the water, as a current that is too strong gives a dusty layer which is not permanent. Under the action of the oxygen liberated at the anode, a layer of black oxide forms on the metal. This layer can be easily polished, steel giving the best results, while on cast and rod iron a more dusty layer is obtained, though the use of distilled water makes the polish permanent.

THE FORMATION OF PETROLEUM.—The theory is held by Professor Mendeleef that petroleum is produced by water, which penetrates the earth's crust, and comes in contact with glowing carbides of metals, especially those of iron. The water is decomposed into its constituent gases, the oxygen uniting with the iron, while the hydrogen takes up the carbon, and ascends to a higher region, where part of it is condensed into mineral oil, and part remains as natural gas, to escape wherever and whenever it can find an outlet. If this assumption is correct, and a sufficient store of metallic carbides is contained in the earth's interior, petroleum may continue to be formed almost indefinitely and yield a supply of fuel long after coal has become exhausted. Professor Mendeleef supports his views by producing artificial petroleum in a manner similar to that by which he believes the natural product is made.

THE WOOD OIL INDUSTRY OF SWEDEN.—The French scientific journal *La Nature* states that the extraction of oil from wood in Sweden is becoming year by year a more important industry. Those parts of the trees which have hitherto been regarded as useless, such as the stumps and roots, are no longer left in the forest to rot, but are subjected to various methods of treatment, by which not only wood oil but also turpentine, creosote, acid of vinegar, charcoal, and tar are obtained from them. The oil as it is now usually extracted cannot be burnt in ordinary lamps, for it smokes too much. But it may be used in special lamps, which are not dissimilar to the usual photogen lamps. The latter can easily be adapted to wood oil, and when the oil is mixed with a certain quantity of photogen it may be consumed in ordinary lamps. It costs about 3d. per pint, it does not explode, and lasts 25 times longer than photogen. When intended for lighting it is extracted wholly from pines and firs. Thirty factories in Sweden make its extraction part of their business, and the production is now considerable.

LIVERPOOL UNIVERSITY COLLEGE.—At the monthly meeting of the council of this college, on the 6th inst., it was announced that the Earl of Derby, the president, had received a letter from Mr. Henry Tate, offering £16,000 for the completion of the library block of the new college buildings. His lordship hoped that it would be possible to connect Mr. Tate's name with the building in recognition of his munificent gift. The council passed a resolution thanking Mr. Tate for this gift, and acknowledging the generous support which Mr. Tate has from the first extended to the college in aiding its original foundation, in contributing more generously than any other donor towards the endowments attending its admission into Victoria University, and crowning his previous acts of liberality by a gift which would enable the council to proceed at once with the erection of the entire building. It was also decided that Mr. Tate's name should be prominently associated with the college library, and Mr. Rathbone, M.P., having offered to have a bust of Mr. Tate executed, to be placed in the library, the offer was accepted with thanks.

Corrosion of Steel from Galvanic Action.—A remarkable and quite unprecedented misfortune has happened to the sloop Nymphe, which is completing for commission at Portsmouth. The vessel, which was laid down in July of last year, was only floated out of dock a few months ago. At the time the water was admitted, the after and upper portions of the hull, as well as the rudder, were coppered, the ends of the propeller shafts to which the twin screws are fitted being covered with paint to prevent their rusting. When, however, the water was pumped out of the dock whither the sloop had been taken to be prepared for her steam trials, an alarming state of things was discovered. The water seems to have percolated the composition and set up a powerful galvanic battery between the copper and the steel. As a result the exposed parts of the propeller shafting are seriously damaged, ruts an inch broad having been eaten out of the steel, while the key-pieces are bitten away at the sides. The propeller shafts are 45ft. long, manufactured out of a single ingot, and the injury is so great that new ones will probably have to be fitted. Where the nuts were screwed into the ends the threads were in a perfect state of preservation, and it is evident that had the usual precaution of covering the exposed surfaces with zinc caps been followed no harm would have sustained.

Engineering Society, King's College, London.—At a general meeting of this society, held on October 30th, the President in the chair, Mr. C. Mittlehausen read a paper on the " Maxim Gun." The author commenced by briefly referring to the new automatic and semi-automatic three and six pounders now being introduced, but he took for his type the automatic 0·45 calibre (kindly lent for the occasion by the Maxim Co.), and showed by means of diagrams and models how the violent and rectilinear motion from the energy of the recoil is utilised for working the gun by converting it into a steady rotary motion by means of a crank, which causes a shaft to rotate in one direction, the counter movement being obtained by means of a spiral spring. This crank shaft works the loading and piercing mechanism, the essential parts of which are contained in a small breech bolt, which, being furnished in duplicate, can be replaced in a few moments in case of accident. He also contended that the automatic system alone could be relied on for preventing "jamming" from "hang-fire" cartridges, whilst a mechanical as opposed to a gravitation feed prevented it when the gun was fired at a great elevation with extreme rapidity. He also believed the single-barrel system, in conjunction with the water jacket, accounted for the accurate firing which the Maxim gun had displayed at the different trials he cited. After a vote of thanks to Mr. Mittlehausen, the meeting adjourned.

The Growth of British India.—An appendix to the new Indian statistical abstract contains a table showing the increase in the area and population of India since 1842. In that year the area was 626,000 square miles, in 1844 it increased to 675,000, in 1847 to 694,000, in 1848 to 699,000, and so down to 1855 more or less was added every year (except 1852), until it reached 832,000 square miles, and in 1856 it rose to 856,000. At this it remained until 1865, when this increased to 860,000; in 1882 this rose to 868,256, and in 1886 to 947,887 square miles. So that British India in 1886 was half as large again as it was in 1842. Perhaps this extraordinary increase will be better understood when put in this way: Since 1842 an area equal to that of France, Italy, and Belgium has been added to that of British India—that is, to British territory in India, excluding the native States. In 1842 British India had an area equal to that of France, Spain, and the German Empire to-day; by 1852 an area as large as Italy and Portugal together was added to this; by 1862 a further area as large as Hungary was added; by 1882 this was increased by the area of Holland; and by 1886 an area equivalent to that of the whole German Empire, excluding the kingdom of Prussia, was added to this. The area of the native States under British protection, which are not included in the above examination, is roughly equivalent to the combined areas of the Austro-Hungarian Empire, Spain, Portugal, and Italy.

An Electric Mountain Railway.—An electric mountain railway—the first of its kind—has recently been opened to the public at the Burgenstock, near Lucerne. Hitherto it has been considered impossible to construct a funicular mountain railway with a curve; but the new line up the Burgenstock has achieved that feat under the superintendence of Mr. Abt, the Swiss electrical engineer. The rails describe one grand curve formed upon an angle of 112 deg., and the journey is made as steadily and smoothly as upon any of the strict funiculars previously constructed. A bed has been cut for the most part out of the solid rock in the mountain side from the shore of the Lake of Lucerne to the height of the Burgenstock—1,330ft. above its level, and 2,860ft. above the level of the sea. The total length of the line is 938m., and it commences with a gradient of 32 per cent, which is increased to 58 per cent after the first 400m., and this is maintained for the rest of the journey. A single pair of rails is used throughout, with the exception of a few yards at half-distance to permit the two cars to pass. The motive power, electricity, is generated by two dynamos, each of 25 H.P., which are worked by a water-wheel of 125 H.P., erected upon the river Aar at its mouth at Buochs, three miles away. Only one man is required to manage the train, and the movement of the cars is completely under his control. One dynamo is sufficient to perform the work of hauling up and letting down the cars containing fifty or sixty persons. This interesting undertaking has been carried out at a cost of £25,000.

SELECTED PATENTS.

APPLICATIONS FOR LETTERS PATENT.

November 2nd.

15803 Fire-bars, J. F. Reyner, Nottingham.
15805 Discharging Grabs, J. H. Morgan, Liverpool.
15807 Steam Engines, G. Kapp, Manchester.
15808 Ball Valves, B. P itt, Bristol.
15814 Engines and Pumps, G. W. Newall, London.
15822 Engine Packings, W. Briggs and A. S. Fox, London.
15829 Internal Tube Cutter, S. Williams and G. Lloyd, Newport.
15840 Gas Motors, A. J. Boult, Middlesex. (E. Capitaine, Germany.)
15841 Igniting Apparatus, A. J. Boult, Middlesex. (E. Capitaine, Germany.
15842 Cut-off Valve, W. P. Naish, Middlesex. (J. H. Eickershoff, United States.)—[Complete Specification.]
15845 Motors, A. J. Boult, Middlesex. (E. Capitaine, Germany.)
15846 Friction Clutch, A. J. Boult, Middlesex. (E. Capitaine, Germany.)
15856 Vacuum Pumps, R. Kennedy, Glasgow.—[Complete Specification.]
15861 Cutting Bricks, B. Kent and W. Kent, London.
15866 Steam Pipes, H. H. Lake, London. (— Gleich, — Krause, and — Chenery, United States.)—[Complete Specification.]

November 3rd.

15882 Petroleum Engines, J. Roots, London.
15885 Steam Engines, M. Paul, jun., Glasgow.
15898 Stuffing Boxes, N. Macbeth, Manchester.
15903 Manual Fire-engines, W. H. Lloyd, Birmingham.
15907 Soldering Tools, T. K. Abell, Liverpool.
15912 Forging Machines, C. Frederick, London.
15926 Breaks, G. Mills and F. F. Ommanney, London.
15928 Engines, E. Duvalle and A. Dousson, London.
15932 Steam Boilers, J. J. Barclay and A. McFarlane, London.

November 5th.

15947 Electric Traction, C. B. Burdon, Liverpool.
15951 Lock-nutted Bolt, C. A. Herzog, London.
15952 Tools, J. Williams, London.
15953 Oil Cans, T. F. Braime, London.—[Complete Specification.]
15954 Twisting Machinery, T. S. Tetley and T. Pickles, London.
15957 Brake, J. H. Shorrock, London.
15958 Consumption of Smoke, J. Hilton, E. Jackson, and G. C. Hilton, London.
15963 Putting Belts on Pulleys, J Harkness, Middlesex.
15968 Lubricating Device, J. Snowdon, the younger, London.
15976 Crushing-mills, R. W. Deacon, London.
15988 Lubricating Apparatus, P. Hubert, London.
15991 Machinery, T. Mallinson, London.
15995 Consuming Smoke, R. H. Mitchell, London.—[Complete Specification.]
15998 Pumps, A. J. Boult, Middlesex. (E Capitaine, Germany.)

November 6th.

16001 Signals, J. Gardner, Preston.
16003 Ore-feeders, F. A. Huntington, London.—[Complete Specification.]
16009 Carding Engines, J. Thompson, of the firm of Messrs. Curtis, Sons, and Co., and T. Barker, Manchester.
16010 Shuttle Drivers, J. F. Ashton, Manchester.
16012 Shuttles, L. Heap and E. Stansfield, Rochdale.
16015 Engines and Pumps, A. G. Mumford and A. Anthony, London.
16016 Slide Valves, G. W. Cisco, Manchester.—[Complete Specification.]
16017 Throttling Devices, G. W. Cisco, Manchester.—[Complete Specification.]
16029 Steering Gear, J. Caldwell, Glasgow.
16032 Duplex Balanced Governor, J. Hewitt, Hyde.
16040 Iron, A. G. Greenway and J. C. Stitt, Liverpool.
16042 Steam Generators, J. Blake, Liverpool.
16047 Railway Signals, W. P. Thompson, Liverpool. (The Pennsylvania Steel Company, United States.)
16048 Storage Batteries, W. P. Thompson, Liverpool. (C. H. Thompson, United States.)
16049 Roller Mills, W. P. Thompson, Liverpool. (C. G. W. Kapler, Germany.)—[Complete Specification.]
16050 Lubricators, J. Neuhold and A. Pellis, London.—[Complete Specification.]
16051 Drying Apparatus, C. Huelser, London. (M. Reuland, Germany.)
16057 Engines, H. Lindley and T. Browett, London.
16058 Shuttle Guards, G. Shepherd and G. H. Pilling, London.
16061 Steel and Iron, H. J. Smith, Glasgow.
16066 Rail Joints, J. M. Price and B. H. Lightfoot, London.—[Complete Specification.]
16072 Rotary Engines, R. Haddan, London. (J. H. Dow and H. H. Dow, United States.)—[Complete Specification.]
16074 Steam Boilers, C. E. Lyon and F. Broughton, London.
16076 Taps, R. W. Thomas, London
16077 Lifting-jacks, F. Tentschert and A. Stehlik, London.
16078 Furnaces, R. Marshall, London.
16079 Governors, W. Johnson, the younger, London.

November 7th.

16084 Automatic Regulator, R. Dowson, J. Taylor, and E. Roberts, of the firm of Dowson, Taylor, and Co. (Limited), London,
16094 Stop-gear, H. Whittaker, London.
16125 Injectors, E. Davies and J. Metcalfe, London.
16132 Pumps, W. P. O'Neill, London.—[Complete Specification.]
16137 Car Couplings, A. Paul and S. Ehrenwerth, Berlin.—[Complete Specification.]
16144 Drilling Machines, J. Connolly and T. Connolly, London.—[Complete Specification.]
16145 Moulding Machines, J. Connolly and T. Connolly, London.—[Complete Specification.]

PUBLISHERS' ANNOUNCEMENTS.

BACK NUMBERS of "The Practical Engineer," from the commencement, can be obtained at either of our Offices in London or Manchester, or by order of any Newsagent.

Vol. I. (bound), containing Nos. 1 to 44 inclusive, from March to December, 1887, price 6s. 6d., can still be obtained by order from any Newsagent, or will be forwarded, carriage paid, from either of our offices on receipt of the amount by postal order or stamps.

Numerous complaints having been made to us by Subscribers of the difficulty they experience in obtaining copies of *The Practical Engineer* in certain districts, we have to state that the Journal can be obtained by any Newsagent through the ordinary trade channels, and no difficulty should therefore exist in obtaining copies *by order* of any Newsagent.

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EDITORIAL NOTICES.

All communications for the Editor of this Journal should be addressed to 6, Victoria Station Approach, Manchester.

Communications intended for insertion in the current week's issue should reach us not later than Tuesday Evening.

We cannot undertake to return rejected manuscripts or drawings unless accompanied by a stamped and directed envelope.

Contributors are requested to write on one side only of the paper. Sketches should be sent on separate sheets.

TO ADVERTISERS.

Advertisements intended for insertion in the current issue should reach our Manchester Office on Wednesday Morning *at the latest.*

TO OUR READERS.

As we fully explained in our issue of the 9th inst., the price of *The Practical Engineer* will, in future, be increased from 1d. to 2d. As will be perceived on reference to this issue, the size of the Journal has been considerably enlarged, and we trust that the improvements effected will commend themselves to our readers and friends. We also take this opportunity of acknowledging the many complimentary letters we have received during the past week with regard to the alterations that have been made.

THE
PRACTICAL ENGINEER.
NOVEMBER 23RD, 1888.

TRADE OUTLOOK FOR THE WINTER.

The signs and symptoms of improving trade, so long anxiously looked for, have developed rapidly during the past few weeks, so that the prospects of a good winter seem now to be fully assured. From all parts of the country there come reports of increasing activity, consequent on increased demand, and of augmented wages asked for and obtained. That sure barometric sign of improving trade, namely, substantial advance in prices, is apparent on every hand.

Briefly summarising the events of the last month or two, the price of Staffordshire marked bar iron was advanced on the 11th Oct. by 10s. per ton; unmarked bars in the Midlands have also advanced about 5s. per ton. Staffordshire and Shropshire all-mine pig has been advanced 5s. per ton. The ironworkers in the Midlands have obtained an advance of 6d. per ton on puddling, and 5 per cent on millmen's wages, and are seeking a further advance. In the Birmingham and Wolverhampton districts the colliers have received a 5 per cent increase in wages, with the promise of a similar increase if 10 per cent advance becomes general. Some of the West Bromwich and Tipton masters conceded the 10 per cent without hesitation. The North Wales Coalowners' Association, assembled at Chester, raised the wages of the underground workmen 10 per cent. The impending strike of Yorkshire miners was happily averted by a timely concession of the terms asked. Two and a half per cent has been conceded to the Lanarkshire colliers, and again 5 per cent. An advance of 10 per cent has been general in the Manchester district and in Derbyshire, and indeed now in most districts.

The improvement in trade is also benefitting engineering and the cognate industries. In the Manchester district engine-builders and boiler-makers are busy. In some districts the labour market is unsettled; in others substantial advances have been conceded. The engineers in the Potteries have received the increase of 2s. for which they asked. Messrs. Bow, McLachlan, and Co., of Paisley, have given an advance of 5 per cent to their engineering hands. Moulders' wages have been increased 2s. at Dundee, and those of engineers 1s. From Glasgow it is reported that prices are likely to rise.

In some of the cognate manufactures the effect of increased demand is apparent. In the Midlands the best thin iron and steel and tinned sheets have been advanced £1 per ton; black sheets, for galvanising, have gone up 10s. per ton; and the makers are reported as never busier. The prices of iron tubes for gas, water, and steam have been advanced 7½ per cent by reduction of discount. Even brass and copper wire have gone up ½d. per pound, and Nettlefold's screws have advanced 5 per cent by a reduction to that amount in the discount.

The steel industry in all its branches is, and has been for a good while past, exceptionally brisk, and there is no likelihood of a lull occurring yet. The Sheffield firms are very busy. Good orders have been booked at Glasgow, and the manufacturers are looking for an advance in prices on new orders.

Lloyd's return for the quarter ending September 30th records 400 vessels in course of construction, as against 249 in the corresponding quarter of last year, the gross tonnages being 698,995 and 394,340 respectively. Of this 400, 260, having a gross tonnage of 483,022, are for the United Kingdom; 6, with a total of 6,470 tons, for the colonies; and 13, with a total tonnage of 36,916, are for Germany. The number of steamships being built of steel is 279, against 143 in the corresponding quarter of last year; of sailing ships, 27, against 10 in the same period. The Board of Trade returns for October show an export trade of iron and steel to the value of £2,291,223 against values of £2,097,784 in October, 1887, and of £1,943,319 in October, 1886.

Now, these selected and summarised notes betoken a condition of things which is, to say the least, highly satisfactory. We wonder how those people who are for ever croaking about our trade going to the dogs, through lack of technical training, and in consequence of our high rates of wages in comparison with those of foreigners, will account for the inflow of this tide of industry. However high our standards of wages and of living, and however deficient our workmen may be in theoretical studies, it appears that when there is trade to be done we get our fair and full share thereof. Our opinion is that we shall hold our own so long as we are an industrious, a happy, and contented people, and no longer. The superior energy engendered of good living is more than a match for low prices obtained by starvation wages, even though backed by so-called technical knowledge.

Since we are in for a good winter's work, we hope that manufacturers and limited liability companies will profit by the costly experiences of the past, and not repeat the folly of investing excessive amounts of capital in the laying down of extensive new plant, a course which invites speedy commercial and financial collapse. "Raw haste" in business, as in other matters, is to be deprecated. Jonah's gourd withered at a rate proportionate to its too rapid growth. Neither, we trust, will the workmen be desirous of long spells of systematic overtime, to the injury of health and the exclusion of the unemployed. We believe there is ample plant in the country for all the trade we are likely to get in the immediate future, and the regular working hours should suffice for the toil which has to be carried on amidst dust and grease within factory walls.

Concerning the movements for advances in wages, we have the heartiest sympathy with all efforts which have for their object the improvement of the condition of those who toil in our factories and mines. In many instances also we are sure that they know their own wants and their own business better than we ourselves can know them. But to those who are striking, and in many cases obtaining advances in wages, we may offer, as disinterested outsiders, just one word of caution. Things are not always what they seem; and it must be remembered that the gains of the employers, which appear to be so large when regarded in bulk, are in reality the result of very small profits on labour. The percentage rates of dividend of co-operative societies and limited liability companies show this; the failure of some firms illustrates it yet more forcibly. If the whole of the profits which now go into the pockets of those who are leaders of industry were taken from them and divided among the labourers, each man's share would be very small indeed. Therefore an advance, say of 10 per cent, does not mean 10 per cent less profit to the employer, but usually an advance to that extent at least to the consumer. As everything relating to supply and demand tends to equalisation, it is absolutely certain that in course of time the 10 per cent advance to the workmen, considered in relation to its purchasing power, will no longer represent an addition of wages to that extent.

This, however, does not represent the whole truth, because a period of industrial enterprise must in the nature of things be fraught with the blessings due to human energy and industry, and the result is that the standard of material comfort at such a period is raised all round. Therefore a period of good trade should be, and must be if turned to the best account, beneficial alike to employer and employed. One is as much entitled to derive advantage therefrom as is the other. Consequently we do not blame workmen for asking an advance when the time of good trade has set in. But we do say that these matters should be discussed in a calm, dispassionate spirit, and the melancholy spectacle of a strike avoided if possible. Better even, we think, to suffer some injustice than to resort to that barbarous procedure.

At these times of returning trade workmen are told that they should not be so impetuous, but wait awhile until events develop, and the advanced prices shall have become firm and assured. To this the men retort, and reasonably, that wages are usually lowered immediately trade begins to slacken, and therefore, should they in improving times wait its full development, the tide may turn before they have derived any advantage therefrom.

This question of wages becomes a tender point, upon which masters and men alike are very sensitive. In such a matter both parties must learn to meet on an equal footing, as parties to a common contract for mutual interest. If a sliding scale could be adopted in all trades, as is the case in some, questions of advances or reductions in wages might be adjusted more amicably at times of fluctuation in trade than they are under existing conditions.

TECHNICAL INSTITUTES FOR NORTH LONDON.

If we may judge from the number of technical institutions in course of construction, or proposed to be erected, London promises to be shortly well endowed with facilities for affording the instruction which is regarded by some as the only thing needed to maintain British supremacy, and as an unfailing remedy against trade depressions in the future. We have alluded on previous occasions to the scheme for establishing technical institutions in South London, and towards which the Charity Commissioners, with princely munificence, assented to the appropriation of £200,000 out of the funds of the city parochial charities, on condition that a sum of similar amount was contributed by the outside public.

An appeal is now being made for a similar sum for the erection of four technical and recreative institutes in North London, comprising the boroughs of Finsbury, Hackney, Islington, and St. Pancras, and an influential committee of members of Parliament and others has been formed with a view to promote the scheme. In the circular issued by the committee the necessity for a more advanced education in a technical and industrial direction is pointed out, and to secure this end it is proposed to erect a technical institute in each of the boroughs named. The committee confidently believe that the Charity Commissioners will be prepared, as in the case of South London, to appropriate £200,000, provided a further similar sum is raised by the public. Inasmuch, however, as the powers of the Charity Commissioners expire next year, it is urged that no time should be wasted, so that the present great opportunity may not be lost; while it is confidently expected that the assistance of the great city companies may be relied upon, if those more immediately to be benefited will readily support the scheme.

King's College Engineering Society, London.—At a general meeting of this society, held on November 6, the President in the chair, Mr. Merriman read a paper on "Organ Building." The author commenced by giving a short history of the development of the organ, and gave the particulars of several organs of historic interest. He then proceeded to a detailed description of the mechanism employed, and stated that the introduction in 1830 of the pneumatic lever by Mr. Barker, and its subsequent improvement, had so improved the touch that now in some of our largest organs it is even lighter than that of the piano. With regard to electric action, he stated that the compressed air-chamber was in the back of the wind-chest, the air being admitted to the power-bellows which move the pallets by means of circular valves attached to rods worked by the armatures of electro-magnets, the connection being made by points under the keys which dip into cups of mercury.

PRACTICAL NOTES ON MARINE ENGINEERING.—XVIII.

(*Continued from page* 531.)

Screw Propellers.

As before stated, the best thanks of all connected with marine propulsion are due to the Admiralty officers for their investigation into the subject of propellers, and especially to those who have tabulated and placed before the public the result of these investigations.

Before proceeding with the form, &c., of the blades, we give an extract from a paper by Mr. Simmington, read before the Institute of Naval Architects in 1887, and hope that the following particulars of twin screws will prove of interest to our readers.

Table No. 2.—Particulars of some Recent High-speed Twin Screws.

Ship.	1	2	3	4	5	6
Length—feet	325	315	300	300	220	250
Breadth—feet	63	61	56	46	34	32½
Draught on Trial Forward	26′ 2″	24′ 6″	21′ 0″	15′ 6″	12′ 10″	13′ 1″
Draught on Trial Aft	27′ 3″	25′ 6″	mean.	19′ 9″	15′ 2″	14′ 7″
Displacement—tons	9,690	7,645	5,000	3,584	1,560	1,544
I.M.S.—sq. ft.	1,560	1,237	1,000	744	433	392
Speed of ship—knots	16·92	17·21	13·75	18·18	16·91	17
I.H.P.	11,610	10,180	8,500	6,160	3,115	3,045
Revolutions per minute	107·2	88	120	122·6	150·4	132·1
Pitch of Screw	19′ 5″	22′ 0″	18′ 6″	17′ 6″	12′ 7½″	14′ 9″
Slip per cent.	17·6	10	—	14·2	9·7	11·4
Diameter of Screw	15′ 6″	13′ 0″	14′ 6′	13′ 0″	10′ 6″	11′ 0″
Diameter of Boss	4′ 4″	4′ 11″	3′ 9″	3′ 5″	2′ 9″	2′ 10″
Number of Blades	4	4	3	3	3	3
Blade area of one screw	72	87	60	47	24	24
$\frac{\text{Pitch}}{\text{Diam.}}$	1·25	1·22	1·3	1·34	1·2	1·34
$\frac{\text{Disc}}{\text{Blade area}}$	2·62	2·92	2·75	2·82	3·6	3·96
Immersion of Screw	9′ 0″	5′ 3″	—	4′ 4″	2′ 9″	1′ 10″

Table No. 3.

Ship.			Propellers.				Surface.	Speed of Ship.	Engines. I.H.P.	Revolutions.	Pitch.	Disc.	Pitch without slip.
Length.	Breadth.	Depth.	Diam.		Pitch.						Diam.	Surface.	
Feet.	Feet.	Feet.	ft.	in.	ft.	in.	sq. ft.						
227·7	31·5	21·5	13	10	16	9	55	9⅝	850	66	1·21	2·7	14·7
			15	0	19	0	50	10¾	1000	60	1·26	3·5	18·0
125·5	17·1	8·9	7	9	10	0	22½	11	300	119	1·33	2·09	9·3
274·3	37·4	21·8	16	0	20	0	66	10	850	52	1·25	3·	19·5
127·4	20·5	9·4	6	9	11	9	12	11	250	95	1·55	3·	11·6
			16	0	20	0	60	12	800	64	1·25	3·3	19·0
333·	41·2	29·4	19	0	21	0	83	12	2500	62	1·1	3·2	19·6
226·4	32·4	14·7	14	6	21	6	60	12¼		66	1·43	2·7	13·8
294·	35·3	19·6	16	0	24	0	80	12¼	2640	67	1·5	2·5	17 5
333·2	39·3	26·0	17	0	20	0	85	12½	2200	65	1·17	2·6	19·0
225·4	33·4	15·6	13	0	20	0	60	12¾	2000	84	1·54	2·2	15·3
231·	34·	18·	13	0	16	0	46	13⅝	1600	95	1·23	2·88	14·5
328·	39·	38·	16	0	20	0	75	13⅝	2500	71	1·25	2·7	19·4
221·4	27·	17·	12	2½	16	0	40·5	14½	1600	110	1·31	2·8	13·3
362·6	44·	26·	18	0	22	6	93	14½	3300	70	1·25	2·7	20·1
225·4	30·5	14·	13	0	20	0	60	15¼	2500	93	1·54	2·2	16·6
505·	50·9	36·	24	0	35	6		17	10300	65	1·48		28·
455·	51·	28·5	22	6	29	6	155	17½	10000	60	1·3	2·56	27·2
490·	·49·	37·	23	3	34	6	190	17½	12000	60	1·45	2·2	29·5

We have also given in Table No. 3 the particulars and results of a few propellers in the merchant service, which may be taken as fairly representing the ideas of different engineers. The diameters may be readily compared with those in Table No. 1, page 507. The ratio of pitch to diameter, it will be seen, varies from 1·1 to 1·5, the average of the nineteen examples being 1·34. The proportion of total surface of blades to area of propeller is given in column eight, and varies from 2 to 3·3, the average being 2·71. This table is only useful as illustrating the diversity of opinion yet prevailing in the designing of propellers, but yet it may be of some service to those studying this subject.

In order to give a more definite idea of the vessels belonging to our navy referred to in Table No. 2, and which may be of interest to those who have an opportunity of visiting any of these ships, we may say that Nos. 1 and 2 are vessels of the Barbette type or class, of which our Admiralty have nine, the smaller ones being the Warspite, built at Chatham in 1884, and the Impérieuse, at Portsmouth, in 1883, each about 7,400 tons displacement, and to which the particulars in column 2 appear to refer, though the writer of the paper in question does not say so. Of the next larger sizes there are the Howe and Rodney, the former built in 1885, at Pembroke, and is the vessel whose propellers were reduced in diameter from 18ft. to 15ft. 6in., with an increase in the pitch. At the same time a reduction in the surface of blades was made to the extent of about 18 per cent, with the result that at 107 revolutions per minute the speed was increased to nearly 17 knots with 11,600 H.P.

The case of the Collingwood, another vessel of the same class, and having the same length and breadth, but about 3ft. less draught of water, is interesting from the fact that it was from the trials of this vessel that the above alteration to propeller was made with such satisfactory results. The Collingwood's propellers were 18ft. in diameter, 17ft. 6in. pitch, when she steamed 16·8 knots with 9,570 H.P., and a displacement of about 8,100 tons. Her engines are $\frac{1}{52\text{in.}}$ and $\frac{2}{74\text{in.}}$ cylinders × 42in. stroke each set, and the revolutions 95·5. Blade area 88·3 square feet; $\frac{\text{Pitch}}{\text{Dia.}} = {\cdot}97$; $\frac{\text{Disc.}}{\text{Blade area}} = 2{\cdot}89$.

The third column refers to vessels of the belted cruiser class, of which there are seven, such as the Aurora, built in 1886, at Pembroke, and the Australia and Galatea, built at Glasgow; the Immortalité at Chatham, the Narcissus at Hull, the Orlando and Undaunted at Jarrow. All the former are sea-going armour clads.

The cruiser class of sea service deck-protected ships are represented in column No. 4. They are the Forth, Mersey, Severn, and Thames. The first of these was built in 1886, and the last three in 1885.

In column No. 5 we have the torpedo cruisers Scout and Fearless, built in 1885 and 1886.

Column No. 5 contains the result of trials with the despatch vessels Alacrity and Surprise, built in Jarrow in 1885.

The value of such trials as these to the marine engineer cannot be overestimated, as it is only by careful investigation and correct application of known results that the steady advancement in speed of ships, combined with economy and safety, has been attained. We have on this subject no less an authority than Mr. W. H. White, director of naval construction in 1886, who stated in connection with the trials of the Howe and Collingwood: "These facts furnish another illustration of our want of exact knowledge of the conditions affecting the efficiency of screw propellers; but an attentive study of them cannot fail to be of service to future designing of quick-running engines, especially for warships."

We may say that the machinery of the Howe weighs 1,152 tons, giving at the rate of 10 I.H.P. per ton weight.

It should be stated that the belted cruisers Australia and Galatea, with triple-expansion engines designed by Dr. A. C. Kirk, steamed over 19 knots on the official trials on the Clyde and in Stokes Bay, developing an I.H.P. about 9,200.

Among the earlier experiments of torpedo boats at high speeds we have those of Messrs. Yarrow and Co., who in 1879 tried eight different propellers on one of the first-class boats built about that time for our Admiralty. These trials are very instructive, and there is no doubt they have had a fair share of consideration in connection with the dimensions of many a propeller fitted since that time.

It will be observed that with one exception, No. 2, three-bladed propellers were gradually reduced while the pitch was increased. An investigation of the results at the highest speeds, as shown in table, shows that the most efficient propeller was No. 4, which was 4ft. 4in. diameter, 5ft. pitch, where 23 knots was obtained

Table No. 4.—Experiments by Yarrow and Co.—First-class Torpedo Boat—1879.

No.	Diameter.	Pitch.	No. of Blades.	Area of Blades.	Area of Propeller. / Area of blades.	Greatest speed.	I.H.P.
	ft. in.	ft. in.		sq. in.		Knots.	
1	5 6	4 6	2	496	0·09	20½	550
2	5 6	5 0	3	540	0·157	20¼	450
3	5 2	5 0	2	316	0·1	18	350
4	4 4	5 0	2	540	0·25	23	520
5	4 4	6 0	2	340	0·16	19¾	390
6	3 11	6 0	2	500	0·288	21½	470
7	3 10	5 0 to 6 6	2	520	0·31	20⅛	410
8	3 6	7 0	2	316	0·227	18⅛	410

with 520 I.H.P. We cannot say whether, taken as a whole, this was the best result that might have been expected; our object in putting this data before our readers is rather to point out the value of reliable experiments. Placing this one at 100 per cent, the remainder follow in this proportion :—

No. 4 100%, No. 6 90%, No. 7 84%, No. 5 84%, No. 2 78%, No. 3 71%, No. 1 67%, and No. 8 61%.

These trials also elucidated the fact that at high speed the blades should not be too rigid, but that if they spring a little to the pressure a better result is obtained.

(To be continued.)

McNEIL'S STEEL EMBOSSED MANHOLE DOORS.

The consultative branch of the Marine Department of the Board of Trade have recently issued an interesting report, giving the particulars with regard to some experimental tests made to ascertain the resistance of McNeil's patent corrugated steel covers used for the manhole and mudhole doors of steam boilers, &c. The experiments were conducted at the works of Mr. McNeil, Kinning Park, Glasgow, and the plates of which the doors were made were supplied by the Steel Company of Scotland.

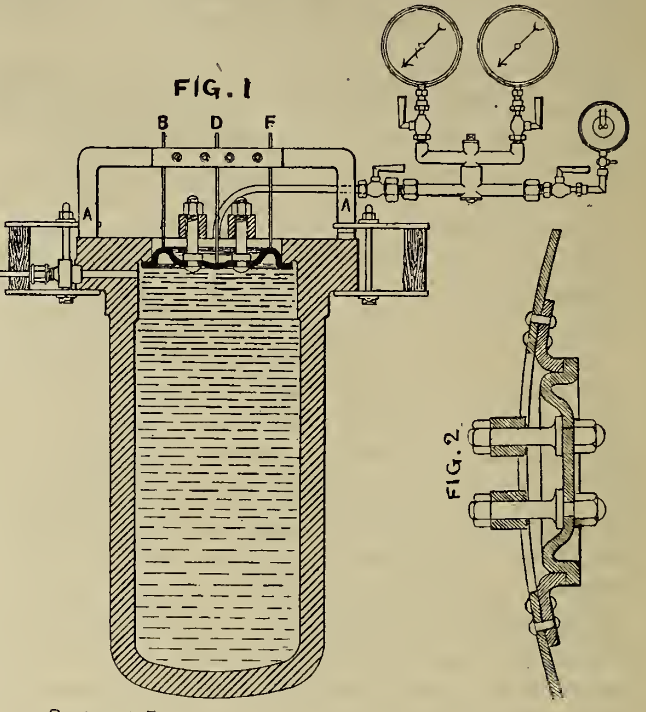
The doors, which are oval in shape and fitted internally, are held in position by two crossbars, with a single stud fixed at the centre of each. The manner in which the doors are corrugated and secured will be readily seen on reference to fig. 2, while the general arrangement of the testing apparatus employed in the experiments is shown on fig. 1.

For recording the pressures up to 2,000lb., two gauges, by Messrs. Dewrance and Company, were used, so that one served as a check upon the other. During the tests the joints of the doors were made with pieces of indiarubber tubing, which was cut to the required length, and tied with twine at the overlap. This material, the report states, answered its purpose admirably. The pressure was applied by means of a hand pump, and as there was practically no leakage from any of the doors, or from the testing apparatus, the pumping arrangements proved very satisfactory.

Twenty-five doors in all were tested; twelve of these had a nominal size in the opening of 8in. by 6in., while the remaining thirteen measured 16in. by 12in. The thickness of the 8in. by 6in. doors ranged from ¼in. to $\frac{9}{16}$in., while the thickness of the larger doors ranged from ¼in. to 1in. A series of pulley tests were made of strips cut from the plates of which the doors were made. The average results of these tests showed the material to possess an ultimate tenacity of 28·3 tons per square inch, with an elongation of 23·4 per cent in a length of 10in.

The results of the tests proved very satisfactory. All the small sized doors, measuring 8in. by 6in. were submitted to a pressure of 2,000lb. on the square inch, and in each case stood the test without failure.

In the case of the larger doors, measuring 16in. by 12in., the one made of ¼in. plates bulged with every stroke of the pump after a pressure of 540lb. was reached. After this, three similar doors, made of $\frac{5}{16}$in. plates, were tested, but in two of the cases signs of failure made themselves manifest at a pressure of 500lb., the doors becoming considerably distorted and beginning to give way. Three of the large doors, made of ½in. plates, were then tested, and stood a pressure of 1,300lb. on the square inch without failure. After this, similar doors, made of ¾in. plate, were tested, the pressure being raised to 2,000lb. In no case was failure manifest, but in each instance the enormous pressure jammed the doors in the mouthpiece. Finally, similar doors, made of plates 1in. in thickness, were tested, and the pressure raised to 3,136lb. on the square inch. In none of these three instances was failure discernible even at this high pressure, but, as in previous cases, the doors after the test were found tightly jammed in the mouthpiece.



Mr. Thos. W. Traill and Mr. Peter Sampson, who conducted the tests, observe in their report that the results show conclusively that "embossed doors constructed of suitable material, well made and well fitted in the orifices which they close, give highly satisfactory results under a gradually increasing load, and they see no reason why their use for the boilers and ballast tanks of passenger ships should not be extended."

NEW EXPLOSIVES.

The numerous attempts that have been made within recent years to discover an explosive for use in mines and quarries which should be safer to handle than gunpowder, and at the same time more powerful and efficient, has led to the invention of a large number of blasting agents.

The character of the explosive known as melenite, which has been adopted by the French Government, will be familiar to our readers from the accounts that have appeared from time to time in the daily press. The compound is believed to be a mixture of fused picric acid in granules with tri-nitro-cellulose dissolved in ether. It is said, however, that the French Government have so much improved upon the original compound that the inventor of melenite would scarcely recognise the substance that is now used in France under that name. The strength of this compound is said by some to be seven times that of gunpowder, though more authoritative statements set it down as only three times.

Another explosive which has recently being discovered is that known as roburite. From a paper on the subject of explosions, by Lieutenant C. E. Vreeland, of the United States navy, and just issued by the U.S. Office of Naval Intelligence, it appears that roburite, which is a German explosive, belongs to what is known as the Sprengel class—that is to say, it is formed by a mixture of two substances, neither of which by itself possesses explosive qualities. In the case of roburite these compounds are solids, and the resulting mixture has a sandy, granular appearance, somewhat resembling raw sugar.

It is claimed for the compound that even when mixed, or ground in an ordinary coffee, cement, or flour mill, the mixture cannot be exploded by friction, percussion, or even the application of flame. Further, that when detonated it produces neither spark nor flame, and very little noxious gas, while it is said to be not liable to deterioration through climatic variations of temperature. From the safety with which it can be handled, it is eminently fitted for use as a bursting charge for shells.

Another explosive which is said to possess several qualities which render it superior in many respects to its rivals, described above, is that known as bellite, which owes its discovery to Mr. Carl Lamm, managing director of the explosives manufactory, near Stockholm, Sweden. It is stated to consist of ammonium-nitrate and di-nitro-benzol, which when melted together at a temperature varying from 176 deg. F. to 194 deg. F. are mixed with saltpetre, and form a compound of which each molecule is explosive. In its loose granulated state, it may be exploded by a small quantity of fulminating mercury, but if pressed into hard cakes it needs a stronger impulse, and a stronger confinement, while the covering, whatever it may be, must adhere to the cake.

Heated gradually in an open vessel, bellite begins to evaporate at a temperature of 302 deg. F., and the rapidity of evaporation increases as the temperature rises, but no explosion occurs. Heated suddenly, bellite burns with a sooty flame; but, if the source of heat be removed, combustion ceases, and the substance assumes a caramel-like structure, the composition remaining as before, save that the proportion of saltpetre is somewhat reduced. Bellite can withstand blows, fire, friction, and vibration without being exposed to the slightest risk of explosion, and it may be stored without danger of spontaneous combustion.

Some interesting experiments and practical trials have recently been carried out in Middlesbrough, in order to demonstrate the safety and power of this explosive. The first day's experiments were conducted in the presence of a large party of scientific gentlemen, and carried out at Messrs. Bell Bros., Clarence Ironworks.

The object of these experiments was mainly to demonstrate the safety and power of bellite, some of the tests being made comparative with dynamite. In the first place, a weight of 1,120lb. was dropped from a height of 20ft. upon a bundle of bellite cartridges placed on an iron plate. The cartridges were merely crushed into a mass, a portion of the mass being afterwards exploded by means of a cap and fuse. Some bellite cartridges were then placed in a paper bag with 1lb. of gunpowder, and the powder ignited, with the result that the cartridges were scattered about in pieces, but not one was either ignited or exploded. Pieces of bellite placed in a smith's forge would neither ignite nor explode, but were merely roasted and frizzled away slowly in the fire. A series of comparative experiments were then made with cartridges of bellite and dynamite of equal weight, exploded on ⅜in. boiler plates. In most cases there was about the same amount of explosive power developed, but in two different directions. With dynamite the plate was either fractured over a small area, or a piece was blown clean out, showing the action to be sharp and local. With bellite the plate was either more deeply bulged than the corresponding dynamite plate, or the fractures extended over a greater area. This shows that the power was more diffused in the latter case, being developed more slowly and being fully utilised before it could get away. This is exactly what is required in mining, it being desirable that the rock should be rent over a larger area rather than shattered over a comparatively small one. The last series of experiments were repeated with charges of both explosives on steel rails, and the conclusion to be drawn from the results were practically the same. A land mine was formed by burying 3lb. of bellite four feet deep in the earth and exploding the charge. Masses of earth were thrown up about 100ft., and a crater 11ft. in diameter and 9ft. deep to the loose bottom was formed. The explosion of 3lb. of gunpowder under similar conditions merely made a hole 4ft. in diameter and 2ft. deep to the loose bottom.

On the following day the party proceeded to the ironstone mines belonging to Messrs. Bolckow, Vaughan, and Co., of Middlesbrough, at North Skelton, to witness the trial of bellite in practical mining. There were at first one or two misfires owing to the use of faulty fuses, but subsequent shots were very effective. In every case the charge of bellite used was just half the weight of the compressed gunpowder which would have been employed in the same borehole. The absence of all noxious gases after the explosion of a charge was very marked. There was a hasty return to the workings after each shot, but in no case were any fumes discoverable such as are generated by the explosion of dynamite in a borehole. It is claimed that bellite is flameless, but there was no opportunity for demonstrating this. In the first day's trials, when charges of bellite and dynamite were exploded in the open, flame issued from the dynamite, but it was not seen to proceed from the bellite.

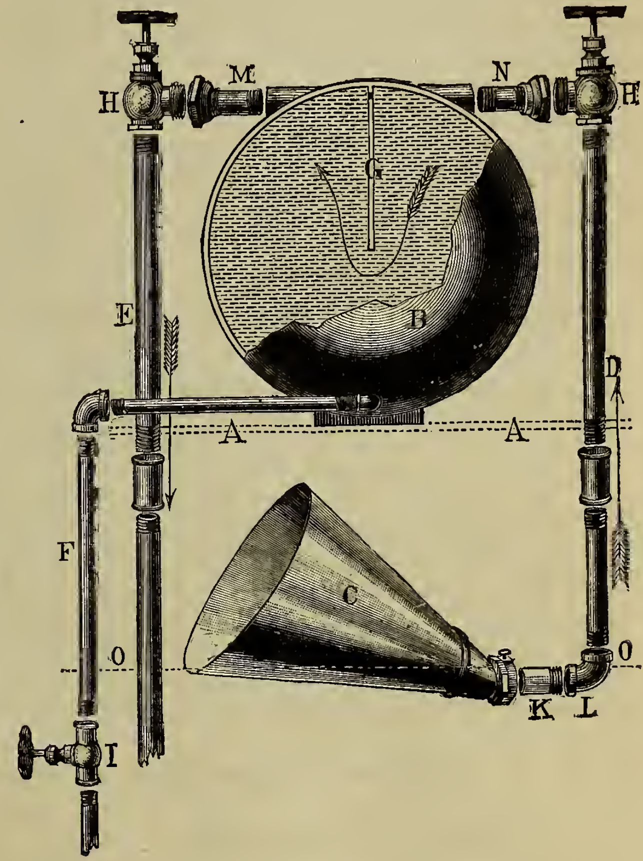
On the whole bellite appears to be a safe and useful blasting agent, and therefore a desirable addition to the list of practical explosives. The explosive is being introduced into this country by the Bellite Company, of 2, Albert Street, Manchester.

THE HOTCHKISS BOILER CLEANER.

The accompanying illustration represents a form of mechanical scumming apparatus, for removing scum and floating deposits which collect more or less on the surface of the water in all steam boilers, particularly when the feed is of a muddy or sedimentary character.

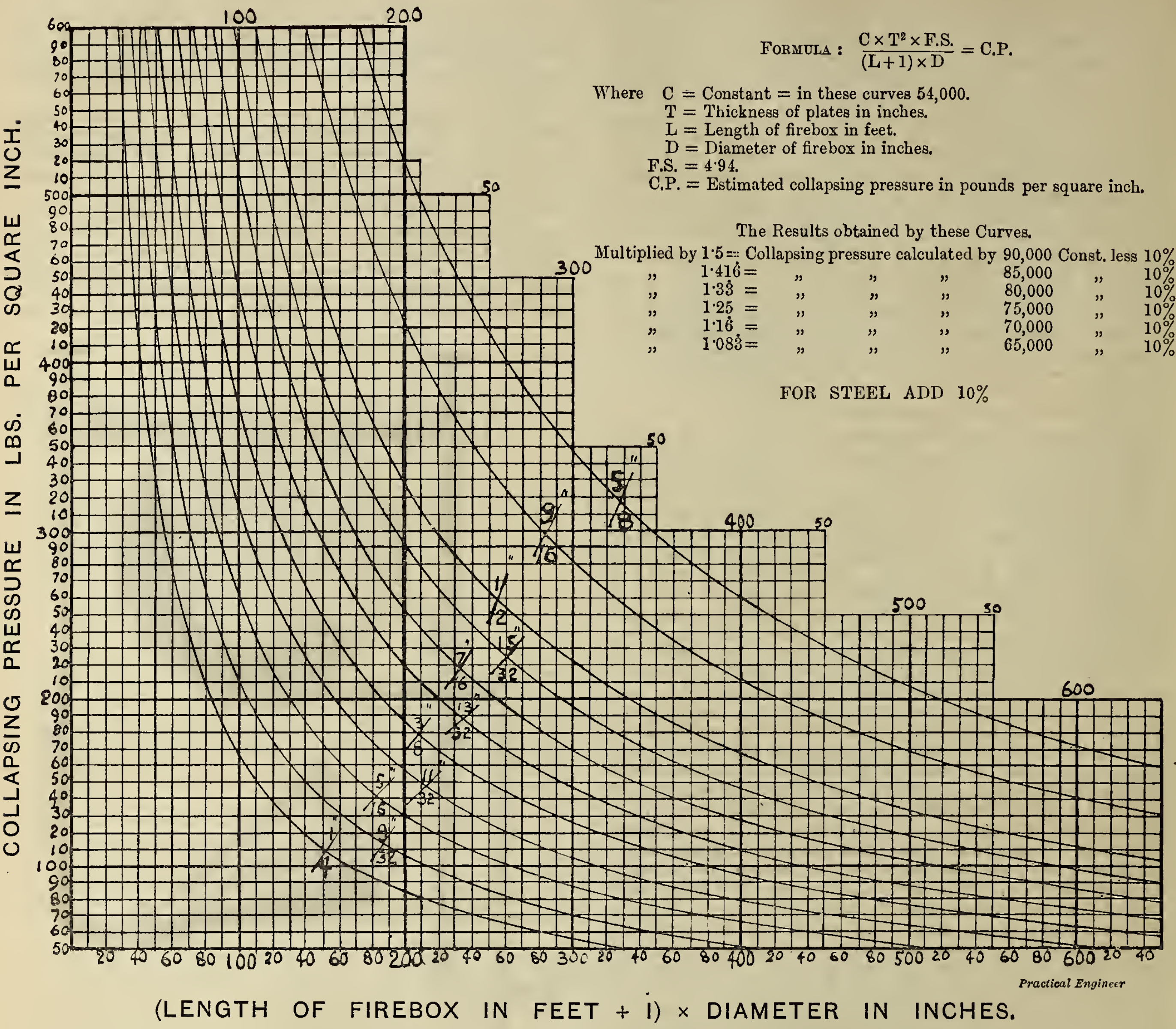
It is not claimed that the apparatus will remove scale bodily from boilers when it is already formed, but it is claimed that by removing the floating deposits the formation of additional scale is prevented, and that the old scale by the expansion and contraction of the boiler soon becomes loose, and is readily detached.

The apparatus has now been in use for a considerable time, working under a variety of conditions with very satisfactory results. Its action will be readily understood by reference to the engraving. The dotted lines AA represent the level of the shell crown, which is usually the most convenient position in which to place the reservoir B. This reservoir is connected with the funnel C, by the up-flow pipe D, and to the lower part of the water in the boiler by the return pipe E. Through this pipe and the reservoir B a circulation is set up which flows in the direction indicated by the arrows. The funnel C is set within the boiler so that the line OO represents the level of low water. The reservoir B, is fitted with a diaphragm G, for the purpose of deflecting the course of the water in its passage, and promoting the settlement of any deposit which has been carried forward into the reservoir through the up-flow pipe D. A blow-off pipe F is connected with the bottom of the receiver B, furnished with a tap which is opened periodically for the removal of the deposit which accumulates in the chamber. HH are two valves used for the purpose of shutting off the reservoir from the boiler whenever required. In consequence of the syphon action of the apparatus, it will be evident that the hot surface water, along with any floating matter that enters the funnel, will be carried forward through the pipe D into the reservoir B. As the water in this vessel is comparatively quiescent as compared with the agitating currents within the boiler, the scum or other floating sedimentary matter which is carried forward gradually settles within it, and is blown off through the pipe F, as already explained, as often as may be necessary.



We should add that the sole agent for the apparatus for the United Kingdom is Horatio Nelson, 90, Worship Street, London, E.C.

CURVES OF COLLAPSING PRESSURES OF VERTICAL FIREBOXES.



Practical Engineer

FORMULA : $\frac{C \times T^2 \times F.S.}{(L+1) \times D} = C.P.$

Where C = Constant = in these curves 54,000.
T = Thickness of plates in inches.
L = Length of firebox in feet.
D = Diameter of firebox in inches.
F.S. = 4·94.
C.P. = Estimated collapsing pressure in pounds per square inch.

The Results obtained by these Curves.

Multiplied by	$1{\cdot}5$ =	Collapsing pressure calculated by	90,000	Const.	less	10%
,,	$1{\cdot}41\dot{6}$ =	,, ,, ,,	85,000	,,		10%
,,	$1{\cdot}3\dot{3}$ =	,, ,, ,,	80,000	,,		10%
,,	$1{\cdot}25$ =	,, ,, ,,	75,000	,,		10%
,,	$1{\cdot}1\dot{6}$ =	,, ,, ,,	70,000	,,		10%
,,	$1{\cdot}08\dot{3}$ =	,, ,, ,,	65,000	,,		10%

FOR STEEL ADD 10%

TABLE OF CONSTANTS.

FURNACES WITH BUTT JOINTS AND DRILLED RIVET HOLES.

90,000	longitudinal seams, welded.	
90,000	ditto	double riveted, with single butt straps.
80,000	ditto	single riveted ditto.
90,000	ditto	single riveted, with double butt straps.

FURNACES WITH BUTT JOINTS AND PUNCHED RIVET HOLES.

85 000	longitudinal seams,	double riveted, with single butt straps.
75,000	ditto	single riveted ditto.
85,000	ditto	single riveted, with double butt straps.

FURNACES WITH LAPPED JOINTS AND DRILLED RIVET HOLES.

80,000	longitudinal seams,	double riveted and bevelled.
75,000	ditto	double riveted and not bevelled.
70,000	ditto	single riveted and bevelled.
65,000	ditto	single riveted and not bevelled.

FURNACES WITH LAPPED JOINTS AND PUNCHED RIVET HOLES.

75,000	longitudinal seams,	double rivited and bevelled.
70,000	ditto	double riveted and not bevelled.
65,000	ditto	single riveted and bevelled.
60,000	ditto	single riveted and not bevelled.

NOTE.—For upright fireboxes of donkey and similar boilers 10 per cent should be deducted from the constants given above.

COLLAPSING PRESSURES OF VERTICAL FIREBOXES.

THE above set of curves, which have been constructed by Mr. J. Howard Reed, of Manchester, will be found useful for estimating the approximate collapsing pressures of upright fireboxes of donkey and similar boilers. The diagram is not put forward as a solution of the question of the strength of fireboxes of this type, but merely as a graphic method of illustrating the published information on the subject given by the Board of Trade.

The curves are based upon a modification of the following formula, which is used by the Board of Trade, and explained in the book of "Regulations and Suggestions as to the Survey of the Hull, Equipments, and Machinery of Steam Ships carrying Passengers,"* provided for the use of their surveyors :

$$\frac{C \times T^2}{(L+1) \times D} = W.$$

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* Published by Eyre and Spottiswoode, East Harding Street, Fleet Street, London, E.C. Price 6d.

Where C = constant, varying as per "Table of Constants."
„ T = thickness of the plate in inches.
„ L = length of firebox in feet.
„ D = diameter of firebox in inches.
„ W = safe working pressure in pounds per square inch.

It will be observed that this formula is used by the Board of Trade for fixing what they consider to be a safe working pressure.

In several Board of Trade reports upon the working of the Boiler Explosions Act, notably in No. 145, it is stated that two fireboxes, fitted with cross tubes, which were tested to destruction by cold-water pressure, were found to possess a mean factor of safety of 4·94 when calculated by this formula. If, therefore, the figures obtained by the formula for the working pressure are multiplied by 4·94, the result will be the estimated collapsing pressure.

Modified in this manner the formula will read thus:

$$\frac{C \times T^2 \times \text{F.S.}}{(L + 1) \times D} = \text{C.P.}$$

where F.S. = 4·94, and C.P. = estimated collapsing pressure in pounds per square inch.

It is upon the above described modification of the Board of Trade formula that the curves have been plotted.

The constant C varies according to the type of longitudinal seam used in the construction of the firebox. Its value decreases from 90,000 for welded seams, or butted seams with double butt straps, double riveted, with drilled holes, to 60,000 with single-riveted lap-jointed seams, with punched holes, and not bevelled—*i.e.*, the laps of the plates at the seams not set back, as they should be, to bring the plates as nearly as possible into a true circle.

In the case of upright fireboxes of donkey and similar boilers, the Board of Trade reduce the constant C 10 per cent, and this practice has been duly observed in the formation of the curves. A table of the varying values of the constant C to suit the various forms of longitudinal seams is provided in the form of an abbreviated extract from the Board of Trade "Regulations and Suggestions," &c. (page 43).

The constant used in the plotting of the curves is 54,000 (60,000, less 10 per cent). The use of this constant makes the curves, as they stand, suitable only for showing the collapsing pressures of iron fireboxes of the weakest and most common type, viz., those with single-riveted lap-jointed longitudinal seams, punched holes, and not bevelled. The collapsing pressures read from the curves can, however, readily be increased to the value of any superior form of seam by means of the multipliers provided for that purpose on the right-hand side of the diagram. In four cases these multipliers have a repeating decimal, so that the result obtained by their use is not mathematically correct, but the discrepancy will, of course, be so small as to have little effect upon the final result, and is therefore of no practical importance.

The curves, as constructed, apply to fireboxes made of iron plates, and the results require to be increased 10 per cent for fireboxes made of steel.

The estimated collapsing pressure of a firebox can be found by means of the curves much more readily than by ordinary calculation. To make the method of using them quite clear to all our readers, we append the following example :—

A firebox 4ft. high, by 36in. diameter, made of $\frac{3}{8}$in. iron plates, with lap-jointed, single-riveted longitudinal seams, with punched holes, and edges not bevelled. To the length, 4ft., add 1 ; multiply this by the diameter, 36in. ; the result equals 180. From the number 180 at the bottom of the diagram follow the vertical line until the curve of the thickness, $\frac{3}{8}$in., is reached ; then follow the horizontal line to the extreme left, where the collapsing pressure, 205lb., can be read from the vertical scale. Should the longitudinal seams of a firebox be of a type differing from the case we have supposed, the figures 205—or whatever the collapsing pressure obtained from the curves may be—must be increased by the multiplier suited to the constant required by the seam in question, and given in the table to the right of the diagram.

If the plates of a firebox are of steel, the final result must be increased 10 per cent, as previously described.

Steamship Service between Hamburg and Calcutta.—A direct line of steamers between Hamburg and Calcutta is about to be established. Several large firms in Hamburg have subscribed 3,700,000 marks, and some banking establishments have taken up eight hundred thousand marks, making the share capital amount to four and a half million of marks. The service will be commenced immediately with six steamers. In consequence of the German shipbuilding yards being at present overfull of work, it is thought the contracts for large steamers will be placed in the English markets.

HOISTING-CRANE USED IN CONSTRUCTING THE EIFFEL TOWER.*

The raising of the various girders and other parts used in the construction of this tower, which, when finished, will reach a height of 984ft., is effected with facility by special cranes..

The tower consists essentially of four piers, each composed of four corner standards, inclined about 50 deg. to the horizontal, this angle increasing as the tower is carried up. These piers are fixed to cast-iron shoes, which rest on, and are bolted to, a massive foundation of masonry. The four standards forming each of the four piers are cross-braced at intervals, and two parallel girders are fixed to the standards of the piers (towards the inner side), to form rails on which the carriage carrying the crane may be moved up as the work proceeds. The idea of making these girders serve this purpose is due to Mr. Guyenet, of Paris. The crane is attached to each pier, and serves to raise all the materal used in the construction of the pier to which it is attached. As the form of the tower is such that the angle of the piers gradually increases (becomes more upright) towards the top of the tower, it is necessary that the crane itself should be able to swing independently of the carriage to which it is attached, so that the crane post may always be set truly vertical. The jib can also be raised or lowered to increase or diminish the radius of the crane ; the range can be varied from 18ft. to 40ft. When the crane has served for hoisting the pieces for one stage, the structure, sliding carriage, and crane together are raised by successive steps of about 5ft. to the next stage ; here it is again fixed to the rails, to be again raised to the next stage as the work proceeds. The crane itself consists of a jib pivoted on to the upright crane post, so that the radius of the crane can be varied. The upper ends of the two tie-rods are formed into eyes, which embrace a pin passing through the sides of the jib near its outer end ; the lower ends of the tie-rods are carried back behind the crane post, and are also formed into eyes, which embrace the gudgeons of a cross-head. Two rollers are also fitted to the cross-head gudgeons, and these bear against rails bolted to the back of the crane post; the centre part of the cross-head is formed into a nut, through which a screw passes, extending from the top of the crane post to a point about half way down the same. This screw is turned by bevel gear and hand-cranks, worked from a stage or platform near the lower end of the crane post. These same hand-cranks are also used for moving the crane round, by shifting their spindle endways, so that they come into gear with a system of bevel and spur wheels, by which the crane is revolved. The lower end of the crane post is carried on a footstep fixed to the lower framework, by which the crane is attached to the sliding carriage; friction rollers are also provided, working in a horizontal ring at a point about half way up the crane post. The framework carrying the whole crane is pivoted to the sliding carriage, so that the crane post may be adjusted truly vertical by a screw at the foot worked by hand from a special stage or platform. The sliding carriage is of braced ironwork, of very rigid but light construction. The screw for raising the carriage, when required, to a higher stage is attached to a small cross-girder, bolted to the ways. This screw is of sufficient length to raise the carriage 20in. ; the small cross-girder being then disconnected from the ways, the screw run home, and then the girder is bolted down ready for another lift of 20in. This process is continued until the crane is raised to the next stage; there are also elaborate arrangements of screw checks, for following up the carriage as it is raised, for safety. In actual use there are two distinct operations, the raising of the crane from stage to stage as the work proceeds, and the raising of the load—*i.e.*, the various girders used in the construction of the tower. A minute description of the cycle of operations necessary to effect the former is given in the article here quoted.

The load, about 3 tons, is lifted by a hand-crab fixed at the lower end of the jib, of special construction, by Mr. Bernier, with two barrels and a safety gear. The chain is of $\frac{3}{4}$in. iron, and the links are $3\frac{7}{8}$in. long by $2\frac{7}{16}$in. wide. The length of the jib is 48ft. ; it is constructed of plate and angle iron, of a uniform depth of $12\frac{5}{8}$in., and $7\frac{1}{4}$in. wide at the top end, and $23\frac{5}{8}$in. wide at the lower end. The whole is described minutely, with the dimensions and weights of all principal parts; also a detailed investigation of the working strains in all the parts, and the illustrations show the crane and carriage in detail. A perspective view of the crane and one of the piers of the tower is also given.

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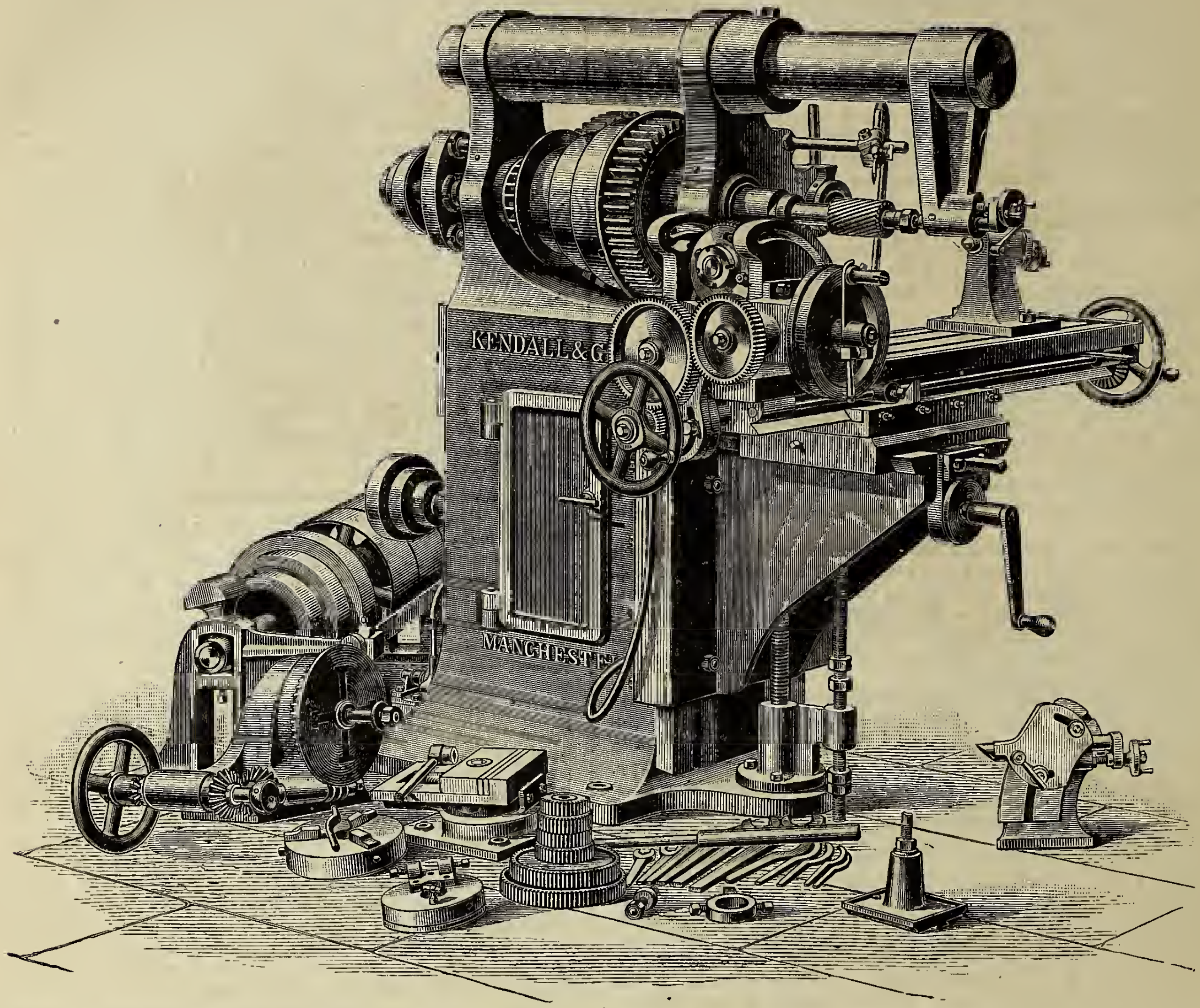
* Foreign Abstracts Proc. Inst. C.E.

IMPROVED UNIVERSAL MILLING MACHINE.

CONSTRUCTED BY MESSRS. KENDALL AND GENT, MANCHESTER.



The above illustration shows a form of universal milling machine made by Messrs. Kendall and Gent, of Manchester. The machine has been constructed so as to combine the principles of the well-known type of American milling machines with the more rigid and substantial method of construction adopted by English makers, and is intended to apply to heavy and general engineering the principles that have been found so very successful in light machine work.

The machine, in addition to all kinds of plain milling work, is also specially adapted for cutting twist drills, rymers, milling cutters, &c., as well as for cutting spur, bevel, worm, and scroll wheels.

As will be seen from the illustration, the main frame carrying the headstock has a vertical sliding front, fitted with tables capable of moving either longitudinally or transversely. The headstock is furnished with a strong steel spindle, provided with a suitable mandrel for carrying the cutters. The spindle runs in hardened conical necks and bushes, arranged for taking up all wear.

The table of each machine is provided with an improved universal headstock, with a hollow spindle for carrying chucks, centres, drivers, &c. This headstock, which can be set at any angle in the vertical plane, is also fitted with a worm wheel and dividing plate for giving the required number of grooves in an object. When cutting spiral grooves the spindle is rotated from the feed screw by means of suitable change wheels. If required, the headstocks may be fitted with Scott's patent dividing apparatus.

The self-acting feed motion is driven at the back of the machine by cone pulleys, which are graduated so as to impart a variety of speeds suitable for the different kinds of work and the various types of cutters.

The machine is made in three sizes, the one shown in the illustration, and designated as size C, being strongly built, and especially adapted for heavy cutting in wrought iron and steel, such as is required in locomotive and marine engineering establishments.

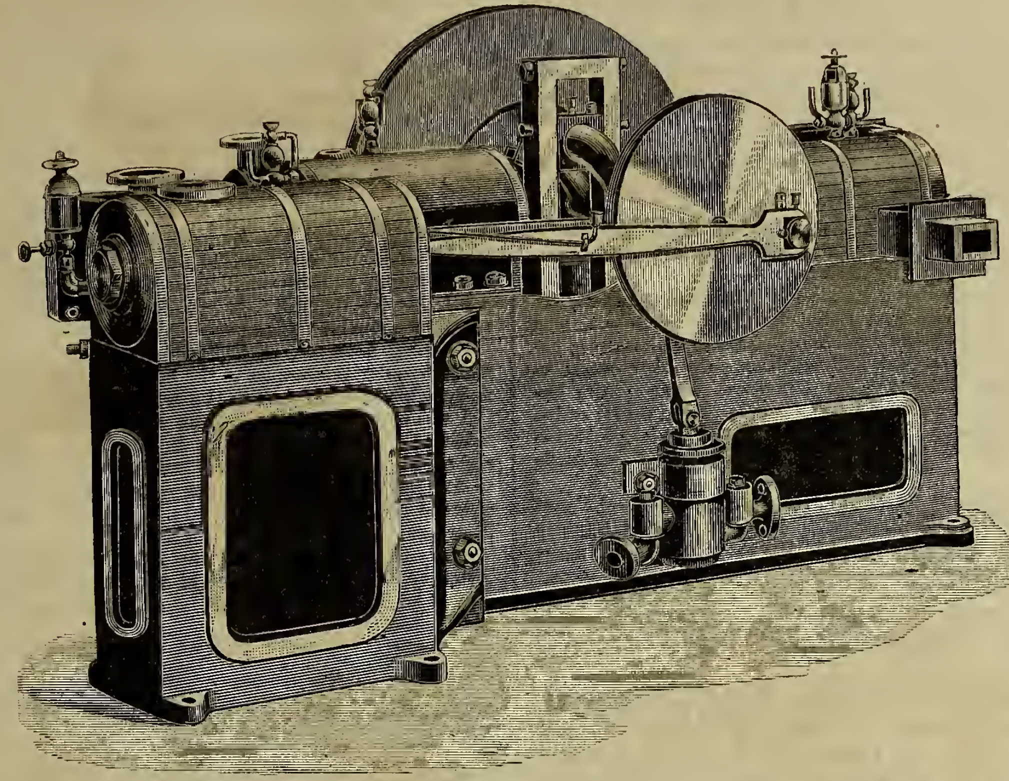
DRY AIR REFRIGERATOR.

We illustrate opposite a cold air machine, constructed by Messrs. Stevenson and Co., of the Canal Foundry, Preston. In its principle of action the machine differs in no way from the well-known manner in which other machines of the same class work, namely, by the compression and expansion of air, without the intervention of chemicals; but in its details there are several entirely novel features which not only simplify the apparatus, but materially increase its efficiency. The illustration shown represents the smallest size which would be capable in a temperate climate of keeping cool a space of 1,000 cubic feet. It will be seen that the machine works horizontally, and comprises an air compression cylinder, an air expansion cylinder, and a steam engine, coupled together on a single crank shaft. The compression and expansion cylinders are single-acting and face each other, their pistons being coupled by means of T-headed rods, which form vertical guide-bars, between which a motion-block driven by the crank shaft slides, thus imparting the necessary reciprocating motion.

In the case of the machine we illustrate, and which, we may add, can be seen at any time at Messrs. Stevenson's works, the steam

DRY AIR REFRIGERATOR.

CONSTRUCTED BY MESSRS. STEVENSON AND CO., CANAL FOUNDRY, PRESTON.



cylinder is also single-acting, and of the trunk type. This, however, is not a necessary feature, as the firm construct them with ordinary engines—simple, condensing, and compound—or so arranged as to be driven from existing power in any convenient way, or coupled with gas engines. The air compressor has an internal liner of manganese bronze, surrounded by the circulating water, which is thus enabled to carry away a great deal of the heat of compression. A pump, which is seen below the disc crank, circulates the cooling water. The air is further cooled by being passed through an apparatus which closely resembles a surface condenser, but which cannot be seen in our illustration. This cooler is filled with brass tubes, and is of special construction, and in proportion to space occupied presents a very large cooling surface to the air. The air and water also, without ever coming in actual contact with each other, continually circulate in opposite directions, so that the greatest amount of cooling is obtained with the least possible quantity of water.

The air compressor valves, which are all of manganese bronze, are of special construction, and work with the greatest ease and precision. The expansion cylinder valves are also so constructed as to throw the least possible amount of friction on the engines; whilst it is an impossibility for the ports ever to block up. The working parts are all adjustable. Steel and manganese bronze are freely used, and great simplicity of construction being a special feature, the liability to break down or wear out is reduced to an absolute minimum, whilst skilled attention is quite unnecessary; indeed in many cases a special attendant would not be needed. Compactness is also a special feature of the machines, and whilst small and light for their power, they run smoothly and with great steadiness and economy.

THE COMPRESSED-AIR COMPANY OF PARIS.*

The establishment for the supply of compressed air in Paris, in the Rue Saint Fargeau, covers an area of about 2½ acres, 40 per cent of which is occupied by buildings; the remainder is appropriated to roads, and to the storage of fuel. For the service of compressed air, there are thirteen steam boilers, of which nine are Paxman's semi-tubular, two are Meunier's semi-tubular, and two are on Farcot's system of removable tubes, giving together a heating surface of upwards of 13,000 square feet. There are, for the same service, ten steam engines, comprising six of Paxman's 350 H.P. compound engines, each of which drives directly a Blanchod compressor; two Farcot engines of 120 H.P. each, driving eight compressors by means of bands; and two Casse vertical compressors; making a total available power of over 2,900 H.P. employed for lighting, pumping, &c. There are twenty-two compressors, of which eight are on Sautter-Lemmonier's system, the air being cooled by means of water tanks, into which the cylinders are immersed; two Casse compressors, cooled by injection of pulverised water; and twelve Blanchod compressors, cooled by injected water.

A vertical steam engine of 25 H.P., having a pair of cylinders, is used for lighting the establishment; also a horizontal engine of 40 H.P., fitted with a pair of cylinders, is used for lighting and for the trial of dynamos.

The compressed air is pumped into reservoirs, seven in number, each having a capacity of 1,060 cubic feet. It may be pumped into reserve pipes when the reservoirs are under repair. The air is conveyed by two 12in. pipes for town supply, and by one 32in. pipe to the Rue Sainte Anne for the service of the pneumatic timepieces. The hot condensing water is collected in a culvert, from which the feed-water for the boilers is lifted by four Worthington pumps; and the remainder of the water is lifted by an additional pump to the summit of the refrigerator, from which it passes to the condensers. Thus the water is continuously circulated in the establishment. To replace losses, the town water is used, and is softened in a purifier, where it is treated by a mixture of soda and lime. The water employed for cooling the air in the compressors is discharged into the reservoirs, and thence to a small cooler, from which it is again used.

The works are lighted by a Gramme-dynamo of 150 amperes, 110 volts, worked by an engine of 25 H.P.; and by a machine of the same power worked by a 40 H.P. engine. The lighting service includes also that of Mr. Popp's property, on which there are 100 glow lamps, and 25 are Mornat arc lights. There is an electrical laboratory, and a dark chamber for testing lamps and regulators; also a chemical laboratory.

For the motive power service there are upwards of 95,000ft. of pipe lines, in cast iron and wrought iron, of from 12in. to about 1in. in diameter. For the horary service there are upwards of 166,000ft. of pipe, forming two principal lines of $1\frac{1}{16}$in. pipe, with branches of from ¾in. to ¼in. bore.

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* Foreign Abstracts, Proc. Inst. C.E.

THE USE OF MACHINERY IN CONSTRUCTION.*

The use of machinery in construction has three main objects in view—accuracy in execution, facility in production or repetition, and cheapening of cost.

The demand for machinery in construction arises generally from these considerations, and it is in relation to the last of these that I purpose treating the subject, and without further reference to other causes for the employment of machinery than admitting that they exist.

Exactness and exhaustless energy in machine tools are too largely used to need any advocacy from me, and the importance of cheapened production needs hardly more, and it is less as a general principle that I call attention to it now than as a resource available to the engineer and shipbuilder in the competition he has to meet from one or two directions.

In competing with foreign countries in constructive works, the machine tool is the English manufacturers' main resource, and may be taken as embodying his experience and as marking his progress. So soon as the English machine toolmaker ceases to be fully employed on new tools for home use, so soon may the English manufacturers retire from the front rank in constructive skill as to the three essentials which lie at the foundation of his business, and which in turn are the foundations of scientific progress.

There are other directions in which competition is to be met by the employment of the machine tool, but it is more directly interesting to us now to look at a result of machine labour in the effect it has had upon hand labour, and the effect it may yet have.

Skilled and unskilled labour constitute undoubted bases of national wealth; hence it is desirable to make the purchasing power of so much of this wealth as may be used as great as possible.

The higher skilled labour becomes, the finer the quality of the wealth it represents, and the greater the useful area it may be made to cover, and it is equally true that machinery in unskilled hands is an efficient means of producing skill. Hand labour and machine labour are growing more inter-dependent day by day, and cannot be entirely divorced, though occasionally serious differences arise between them. Capital, which weds them, is interested in preserving their relationship, and settling its conditions. Had capital been indifferent to these relations during the past fifteen years, English manufacturers and English workmen would ere this have exclaimed "Ichabod" over many a factory, and many a home.

It is impossible in the brief survey of a short paper to deal fully with the question of the relative position of capital and labour (*i.e.*, machine labour and hand labour) to the nation's present position in skilled construction. I can, however, offer some evidence as to the steady and silent evolution of the above propositions over the past fifteen to seventeen years.

Taking 1871-3 as a starting period, there has been a steady rise over the period from that date to the present month in the cost of hand labour of almost all kinds.

In the various branches employed in marine engineering, I find this to be equal to a permanent average increase, including day labourers, of over 21 per cent, ranging over the more highly skilled branches from 38 per cent paid to pattern makers, to over 29 per cent to fitters, and 27 per cent paid to smiths.

Within the same period there have been two large enhancements of the cost of the marine engine and its boilers, the first in passing from the injection condenser types to the surface condenser type, and amounting to probably an increased cost of 20 per cent; the second in passing from the latter type to the triple-expansion type, amounting to a probable total increased cost of 35 per cent, including the first enhancement; and yet, notwithstanding the increased cost of labour and the enhanced cost of the engines and boilers in passing from lower to higher and more costly types, the use of machine tools in our and kindred trades has brought down the total cost to-day to less than the total cost in 1865 or 1871, notwithstanding that labour has increased 21 per cent.

Indeed, taking two equally busy periods, namely, 1873 and 1882, I find the total cost of the compound engine per N.H.P. over 24 per cent less in the latter period than in the former; the cost per N.H.P. for hand labour being reduced—principally by employing machine tools—by as much as 35 per cent.

The effect of the permanent increased cost of hand labour and its constant increase is shown in the increased percentage which it bears to the total cost of every engine, whether of the compound or triple-expansion types, notwithstanding the larger use in the higher types of more costly material.

Taking the following years as representing periods in which the different types of engines were made, I find the percentage cost of hand labour in the total cost of the engines and boilers was in—

1871	from 25 to 27	per cent.
1882	,, 28 to 29	,,
1885	,, 30 to 31	,,

The variations between the percentages given for each period arises from differences in size of engines, or in specifications.

There is thus a steady and constant increase in the cost of hand labour. The rises and falls to which it is liable are not equal; the fall never reaches the average lowness that prevailed before the rise. The cost of materials, on the contrary, tends downwards through the agency of cheaper processes and machine labour, and it is only manual labour that does not accommodate itself entirely to the periodical demand for cheapness, but hedges itself in with its skill and with its combinations, and proves at times inaccessible to reasonable approaches.

So long, however, as skilled labour is equal to the demands made upon it, it remains to the manufacturer to make it go as far as possible in alliance with the machine tool.

I will show how this has been effected already in the following manner. The average artisan in the whole of the classes in an engine works as a producer of horse-power was equivalent in 1873 to 2·0, but by the extended use of machinery his equivalent was reduced in 1882 to less that 1·0; he thus was made only half as important as before.

Carrying this inquiry into the principal classes of skilled men, I find in the following periods the fall in importance of hand labour to be as indicated by the figures placed against them, namely:—

A fitter in 1873		stood in relation to machine labour as			1 : 1 on common engines
Do.	1882	do.	do.	do.	1 : 2·31 on compound engines
A boiler-maker in 1873		do.	do.	do.	1 : 1·0 on low-pressure boilers
Do.	1882	do.	do.	do.	1 : 2·19 on 80lb. to 90lb. high-pressure boilers.

The true reading of these figures is, of course, that the sphere of the machine tool is becoming wider and wider. This will be enforced if I quote some figures I gave in evidence before the Depression of Trades Royal Commission in 1886, namely, that in 1873, to produce 2,260 N.H.P., my company employed an average of 1,022 men, and that in 1882, to produce 5,868 N.H.P., they employed only 1,351 men. In the two periods the N.H.P. varied as 1·5 : 3·7, while the hands varied only as 2·0 : 2·6.

These relations will extend the more the machine tool and the details of the work are brought into suitable relations to each other. The gist of the whole matter lies in that truth. The tool must always follow the work, but in an important sense it must be equally held that, to secure economic working, the design must be made in view of the machine tool which is to operate upon it.

In iron shipbuilding, the adaptation of the structure to the machine tool is an essential step to the extended application of machinery to construction.

The iron and steel ship illustrates very broadly the slow conservatism that pervades English life. The structure of the iron vessel followed as far as could be the wooden vessel it replaced, in being formed of vertical transverse frames and longitudinal planks or strakes. The structure of the steel ship perpetuates the system, only lengthening the individual plates. All regard for the principles of economic construction was overlooked at the outset, and was finally shut out, so that to-day it will require no mean struggle to obtain acceptance of a system of construction combining all needful strength with a more reasonable distribution of the material, and a better command over the cost of production by the extensive use of the machine tool.

There is a wide field in this department for the revision of the details of the structure and the adaptation of the machine tool.

The relative growth of machine labour in this department is not so easy to indicate as in engineering construction, but it is not difficult to show the cost that hand labour has put on over the last seventeen years.

The time wages for all the classes of men employed in the shipyard have acquired a permanent average increase of 25 per cent, ascending from 11 per cent to drillers, to 32 per cent to smiths and carpenters, and to 38 per cent to platers.

The piecework earnings of the members of the Boiler-makers' Society have put on a permanent average increase of 22 per cent over the same period.

There are some curious illustrations amongst the individual piecework averages. The first is in that of the drillers' average, which has actually fallen over the last seventeen years, and if it were removed from the general average, the latter, instead of a permanent average of 25 per cent, would become an average of 32 per cent. It is curious to observe how the driller's skill—the lowest employed in shipbuilding—has gone back in value as machinery has extended and produced more accurate work. On the other hand, the riveters' average has increased by 46 per cent, again illustrating the effect of improved machinery and consequently more accurate work upon the riveters' list of rates. The caulkers' average has risen 32 per cent from the same cause.

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*Paper by John Price, M.Inst.C.E., read before the North-East Coast Institution of Engineers and Shipbuilders, October 20th, 1888.

In all the progress made by the manufacturer in supplying the market with a better and cheaper article—better and cheaper in spite of oppressive and repressive rules for construction, and the conditions under which he has had to fulfil his customers' conditions—hand labour has run him a close race.

I have before me the cost per ton of deadweight of a vessel built in 1865, and carrying 1,700 tons—a large ship in those days. It is £10 13s. 11d. per ton, of which 30·64 per cent was for hand labour. I have another built in 1873, and carrying 2,477 tons deadweight, the total cost per ton of which was £10 2s. 5d., of which 24 per cent was for hand labour. Since the last date the percentage of labour in the total cost per ton of deadweight for the hull has been for the following years as follows:—

1882	34 per cent.
1884	34 „
1886	34 „
1887	34½ „

These averages are mostly taken upon large vessels; in smaller vessels they rise to 36 and 38 per cent. You therefore find that the cost of hand labour upon the hulls of vessels has reached the proportion of its cost upon engines, and indeed has exceeded it.

There is no fundamental reason for objecting to the enhanced cost of skilled, or any kind of labour, in itself. It has a perfect right to fetch its own price in its own market, and if in doing so no social or economic law is transgressed, and the community is bettered by it, we have reason to encourage rather than to discourage it. And it must not for a moment be assumed that I am discussing this except as an economic question affecting constructive work, and through that our respective industries, just as we may discuss the use of coal—itself a perfectly harmless and useful article.

Hitherto much of the application of machine tools has been involuntary by the manufacturer. He has been driven to adopt it further and further by inflexible circumstances, which gave him only the unbending alternative of doing it, or of, bit by bit, seeing his capital slip out of his hands; and while this process has been going on—along with a partial voluntary adoption of the machine tool where it could be done cheaply and easily—there has been a counteracting force at work in the upward progress of hand labour cost.

Looking through the figures which I have given above and in the appended tables, a thoughtful student would conclude that the two forces of machine labour and hand labour had been working over the past ten or twelve years with a knowledge of each other's purpose—the one to raise the cost of production, and the other to reduce it. No such intelligent action has, I am afraid, occurred. Capital has only spasmodically rushed in to rescue the trade that was being driven from its home, or was being reduced to slender proportions by a pursuit of the maximum wage.

Two considerations now demand that for the future a systematic application of the machine tool be made a cardinal principle of constructive work. These considerations are:—

Firstly.—The necessity of controlling the cost of production and of cheapening it constantly. The competition with foreign manufacturers is fast leaving to the British manufacturer only his always advanced experience, which, up to the present in constructive work, remains supreme all round. This, as I have already said, must be embodied in the machine tool. The foreign workman is equal to our own so far as mere manipulative skill goes, and although the physical and racial differences give our workmen an immense advantage, this is, as a matter of fact, already almost counterbalanced by the help of the machine tool alone, as it exists in the foreigner's hands, and it is actually found to-day to be *entirely* counterbalanced by the machine tool *and* cheaper living, and lower wages, abroad. Apart from foreign competition, however, it is essential to be able to control the cost and lessen it, when needful, to meet the regularly recurring periods of depression in trade, when he who can sell cheapest not only sells what he produces, but he also keeps the little trade there may be then at home.

Secondly.—The necessity there is now of working the hugest constructive work, as well as the smallest, strictly on the arithmetic of commerce. We sell the largest cargo vessels with their machinery, as well as the smallest, on a price per ton of deadweight. This single ton is so small a unit, any error regarding it, being multiplied hundreds or thousands of times, becomes a formidable matter. This applies both to estimating and carrying on the work. But this method of basing a price on a unit of the whole thing to be sold is common to all constructive work, and is essential to commerce. We are, however, only now realising what this means in shipbuilding and engineering—how the disturbances and disputes in the labour market, and with labour, fritter away the small modern margins of profit; a condition of things which only the most perfect system of costing, and an extended application of the docile, untiring, and perfectly reliable machine tool can avert from becoming disastrous. It has become necessary, therefore, to mechanically control as much of the cost of our structures as it is possible to do, and the great agent in aiding us is the machine tool.

LESSONS IN MECHANICAL DRAWING.—XXIV.

By Prof. A. MacLay, B.Sc., C.E.

GEOMETRICAL LOCI AND POINT PATHS (*continued*).

SPIRAL.

In Lesson XII. a spiral was briefly described as the path of a point which moves round a fixed point as centre, and at the same time moves from it. In further explanation three things may be noted: (1) That to determine the position of the moving point at any instant, we require to know the distance between the two points or the length of the line joining them; and (2) the angle which that line makes with the line through the fixed point and the initial position of the moving point; or (3) the relation between (1) and (2), *i.e.*, the law of the motion.

Referring to fig. 71, Lesson XII., and using the terms explained in connection with "polar co-ordinates" as being most suitable for this type of curve, we may define a spiral as *the path of a point whose radius vector is proportional in some way to its vectorial angle.*

The best known examples are:—

(*a*) Radius vector, directly proportional to vectorial angle. The path is then the curve known as the *Archimedean* spiral.

(*b*) Radius vector, inversely proportional to vectorial angle—the *reciprocal* or *hyperbolic* spiral.

(*c*) Radius vector, inversely proportional to square root of vectorial angle—the curve known to mathematicians as the *lituus.*

(*d*) The logarithm of the radius vector, directly proportional to the vectorial angle—the *logarithmic* or *equi-angular* spiral.

In algebraic notation, if r represents the radius vector, θ the circular measure of the vectorial angle, and c a constant for each curve, then the relation between r and θ in the above case may be represented by the following equations: (*a*), $r = k\theta$; (*b*), $\frac{1}{r} = k\theta$; (*c*), $\frac{1}{r} = k\sqrt{\theta}$; (*d*), $r = k^\theta$ or $\log r = \theta \log k$.

In the following exercises use the 1in. diagonal scale of Ex. 25 for measurements of the radii in inches to the second place of decimals.

EXERCISES.

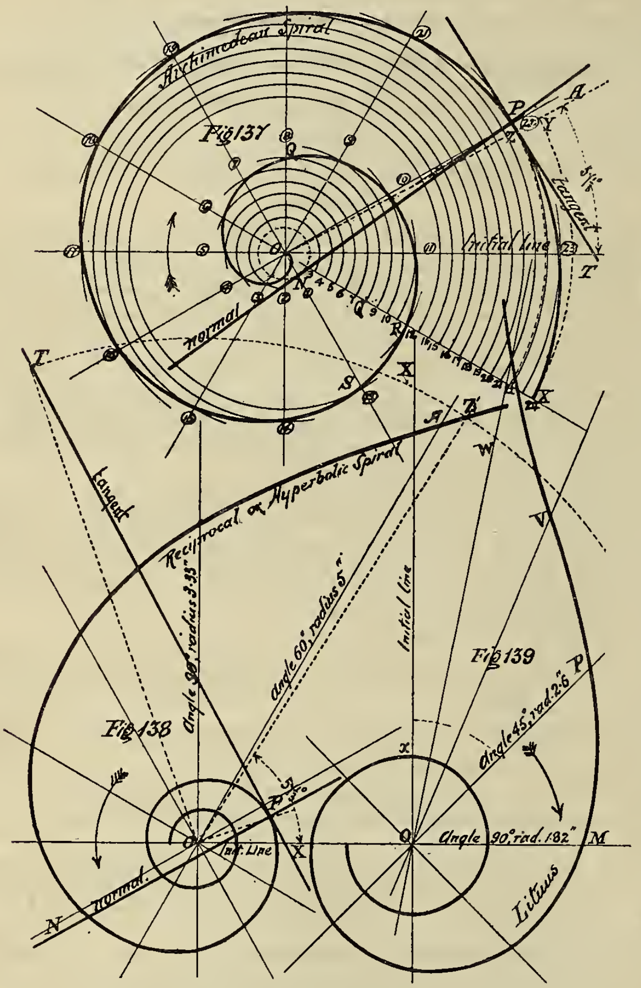
Ex. 151, Fig. 137.—Given OX as the initial position of a line OA, which turns about its one extremity O as a fixed centre. Find the path of a point P, which moves along the line in the direction OA, at the rate of $\frac{1}{20}$in. per 10° of its angular motion. Show two convolutions of the curve; *i.e.*, show the path of the point while the line passes again twice through its initial position.

With the set squares draw lines through O at 30°, 60°, 90°, &c., with OX. Make OX $= \frac{2 \times 360^\circ}{10^\circ} \times \frac{1}{20}$in. $=$ 3·6in. long, and divide it into $\frac{2 \times 360^\circ}{30^\circ} = 24$ equal parts. Draw circles from centre O through these division points, and trace the curve which passes through the intersections of the circles and the radial lines, taken in order, as numbered.

Ex. 152, Fig. 137.—Given the pole or turning centre O, and two positions Q and R of the moving point (on the same convolution), show at least one convolution of the curve which passes through them.

Let the angle QOR be 120°, OQ = 1in., and OR = $1\frac{1}{2}$.

With radius OQ draw arc QQ^1 to cut OR at Q^1. Divide Q^{1}R and angle QOR into same number of equal parts, say four. Draw radial lines and concentric arcs through these divisions as in the last example, and trace that part of the curve which passes through their intersections, taken in order. For continuation of curve produce Q^{1}R both ways, and mark off points at distances $\frac{1}{4}$ Q^{1}R. Also draw radials from O, making angles of $\frac{1}{4}$ QOR with each other. Then draw arcs of circles and radial lines to intersect, as before. If the division of the angle QOR had proved an awkward unit to work with, we should have set off a line OT at 30° with OR, or at some other convenient angle, and have found the part of Q^{1}R, which would give the corresponding alteration of radius.



Ex. 153, Fig. 137.—Draw the tangent and normal at any point P on the Archimedean spiral of Ex. 151.

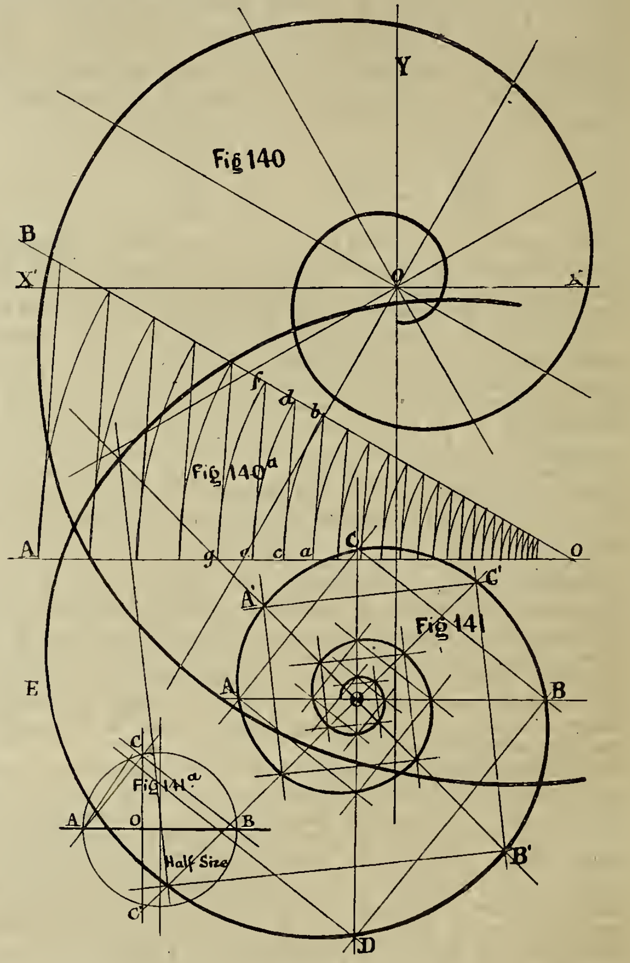
Join OP and draw OS ⊥ OP. With centre O radius c the constant of the curve, viz., the linear distance travelled by P while OA turns through unit angle (in circular measure, the angle subtended at the centre of a circle by an arc equal in length to the radius) draw a circle cutting OS at N. Then NP is the normal at P, and PT ⊥ PN is the tangent. To find c by construction, with centre O and radius OX, for example, draw an arc, and with a short distance, say $\frac{1}{4}$in., step along this arc a distance XY equal to OX. Then YOX is the unit angle, or "radian," as it is often called. Radius OY cuts the curve at Z, then YZ = c, the required radius. We may check the length YZ and the angle YOX by calculation thus: Let n represent the number of degrees in the unit angle. Then by Euclid VI. 33, $\frac{n}{360}=\frac{r}{2\pi r}$ or $n=\frac{360r}{2\pi r}=\frac{360}{6\cdot28}=57\cdot3°$ and $c=\frac{57\cdot3}{10}\times\frac{1}{20}=\cdot28$in.

Ex. 154, Fig. 138.—Given OX as the initial position of a line OA, which turns about O as a fixed centre. Find two or more convolutions of the curved path of a point P, whose distance at any instant from O is inversely proportional to the angle through which the line has turned. Given angle AOX = 60°, when OA = 5in.

With the given angle and radius as a basis, assume any convenient series of values of the angle, and find the corresponding values of the radius, bearing in mind that the latter are to vary inversely as the former; *i.e.*, that if we multiply the given angle by 1, 2, 3, &c., we shall find the corresponding radii by multiplying the given radius by the reciprocals of these numbers, viz., 1, $\frac{1}{2}$, $\frac{1}{3}$, &c. The results may most conveniently be put in tabular form thus:—

Angles in degrees..	60	90	120	150	180	210	240	270	300	330	360 &c.
Ratios of angles...	1	$\frac{3}{2}$	2	$\frac{5}{2}$	3	$\frac{7}{2}$	4	$\frac{9}{2}$	5	$\frac{11}{2}$	6 ,,
Ratios of radii....	1	$\frac{2}{3}$	$\frac{1}{2}$	$\frac{2}{5}$	$\frac{1}{3}$	$\frac{2}{7}$	$\frac{1}{4}$	$\frac{2}{9}$	$\frac{1}{5}$	$\frac{2}{11}$	$\frac{1}{6}$,,
Radii in inches....	5	3·33	2·50	2	1·66	1·42	1·25	1·11	1·00	·90	·83 ,,

Draw OX as initial line, and set off lines at the above angles with it. On OA, which is at 60° with OX, measure off 5in.; on OB, at 90° to OX, measure 3·33in., and so on. Then trace the reciprocal spiral which passes through these points.



Ex. 155, Fig. 138.—At the given point P on the spiral last drawn, draw a tangent and normal to the curve.

Join OP and draw OT ⊥ OP. Set out a line OZ at unit angle ($57\cdot\frac{1}{3}$°) with OX, cutting the spiral at Z. With centre O and radius OZ draw arc ZT, cutting line OT at T. A line drawn through T is the tangent at P. The normal is PN ⊥ PT.

Ex. 156, Fig. 139.—Two lines OX and OP meet at an angle of 45 deg. OP is 2·6in. long. If OP turns round O as a centre in the direction shown by the arrow, trace the path of P if the distance OP varies *inversely* as the square root of the angle XOP, the line OX remaining in a fixed position.

Having first assumed a series of values of the angle XOP, find next the corresponding values of the radius, as in Ex. 154.

Angle in degrees	45°	90	135	180	225	270	315	360 &c.
Ratios of angles..	1	2	3	4	5	6	7	8 ,,
Ratios of radii ..	1	$\frac{1}{\sqrt{2}}=\cdot70$	$\frac{1}{\sqrt{3}}=\cdot58$	$\frac{1}{\sqrt{4}}=\cdot50$	$\frac{1}{\sqrt{5}}=\cdot45$	$\frac{1}{\sqrt{6}}=\cdot41$	$\frac{1}{\sqrt{7}}=\cdot38$	$\frac{1}{\sqrt{8}}=\cdot35$,,
Radii in inches..	2·6"	1·82	1·51	1·30	1·17	1·06	·99	·91 ,,

Set out lines at these angles with the initial line OX, and measure off the radii as ascertained arithmetically, on the 1in. diagonal scale.

We may check some of the points in the curve by the following consideration: When the angles are as 1 to $\frac{1}{4}$, the radii will be as 1 to $\frac{1}{\sqrt{\frac{1}{4}}}$ i.e., as 1 to 2; similarly, when two angles are as 1 to 4, the radii are as 1 to $\frac{1}{\sqrt{4}}$ i.e., as 1 to $\frac{1}{2}$. Thus, if we bisect angle POX by line OV, radius OV should be twice radius OM, since angle XOM is four times angle XOV. Similarly, radius Ox should be half of radius OM, since OM is at 90°, and Ox is at 360° with OX.

Ex. 157, Fig. 140.—In a logarithmic spiral the angles are in *Arithmetic* progression, the radii in *Geometric* progression. Draw a curve to represent that relation.

If A, B, C, D, &c., represent quantities of any kind, and the relation between A and B be the same as that between B and C, C and D, &c., throughout, the quantities are said to be in a progressive series or progression. When any two consecutive terms differ by some constant quantity—*i.e.*, by some quantity which has to be added to or subtracted from the one to make it equal to the other—they constitute an *Arithmetic* progression; but if the difference be of such a kind that the one has to be multiplied or divided by a common quantity to make it equal to the other, they are then in a *Geometric* progression. The distinction may be illustrated as in the following, where c is the common quantity:

Arithmetic Progression.	*Geometric Progession.*
A	A
$A+c=B$	$A\times c=B$
$B+c=A+2c=C$	$B\times c=A\times c^2=C$
$C+c=B+2c=A+3c=D$	$C\times c=B\times c^2=A\times c^3=D$
&c., &c.	&c., &c.

Example :— $A=3$, $c=2$. { A . P... 3, 5, 7, 9, 11, 13, 15, 17, 19, &c.
G . P... 3, 6, 12, 24, 48, 96, 192, 384, 768, &c.

In a G.P., since $\frac{A}{B}=c$, $\frac{B}{C}=c$, $\frac{C}{D}=c$, we may write the series thus $\frac{A}{B}=\frac{B}{C}=\frac{C}{D}$ &c.; or A : B : : B : C : : C : D, &c.

Construction: (1) For the angles suppose $A=90°$, $c=30°$. (2) For the radii let $A=2\frac{3}{4}''$, $c=\frac{10}{9}$.

(1) Having chosen a point O (fig. 140) as pole, and OX as initial line through it, draw with the T square and 30°, 60° set square lines at 30°, 60°, 90°, &c., with the initial line.

(2) Next find a series of lines in geometrical progression, beginning with length $A=2\frac{3}{4}''$. We may do this (*a*) arithmetically or (*b*) graphically.

(*a*) $B=A\times c=2\frac{3}{4}\times\frac{10}{9}=3{\cdot}06''$; then $C=B\times c=3{\cdot}06\times\frac{10}{9}=3{\cdot}40''$, &c.

(*b*) By a modification of fig. 35, Lesson VI., we can obtain a series of lengths in geometrical progression. Thus—

Along any two lines OA and OB, fig. 140^a, measure Oa, Ob, 2·75″ and 3·06″ respectively, two lengths which are in the proportion of 10 : 9. Join ab. With centre O, radius Ob, describe an arc bc, and draw $cd \parallel ab$. Then with radius Od describe arc de.

Now by Euc. VI., 2., $Oa : Ob :: Oc : Od$. But $Ob=Oc$ and $Od=Oe$ by construction; $\therefore Oa : Oc : Oc : Oe$.

Similarly, by drawing $ef \parallel cd$, and by drawing arc fg, we get—

$Oc : Od :: Oe : Of$ But $Od=Oe$ and $Og=Of$.

$\therefore Oc : Oe :: Oe : Og$

Thus $\frac{Oa}{Oc}=\frac{Oc}{Oe}=\frac{Oe}{Og}$ &c., or in other words the lengths Oa, Oc, Oe, Og are in geometrical proportion.

By continuing the construction both to right hand and left of fig. 140^a, we can obtain as many lengths as may be required for drawing the spiral: Length Oa is the radius when the line is at 90° with its initial position OX.

Ex. 158, Fig. 141.—A, O, B are three points in order on a given straight line, AO = 1¼in., OB = 2in. With O as pole, draw a logarithmic spiral to pass through A and B, these points being on the same convolution. Why is this curve also called an equiangular spiral? (1885.)

In the note to the last exercise, it was shown that in a logarithmic spiral any three consecutive radii at equal angles stand in the relation represented by the ratio A : B : : B : C or $\frac{A}{B}=\frac{B}{C}$. B, in that case, occupying, as it does, the place of both the *mean* terms of the ratio, is called a *mean* proportional between the extremes A and C. Now, if A and C be given, we can, by a very simple construction (Euclid VI., 13), find B. Thus if two radii of the spiral be given, we can easily find the length of the radius, which bisects the angle between them.

Example.—Lay off the line AOB to the given dimensions, as in fig. 141a. On AB describe a semi-circle, and at O draw OC ⊥ AB. Then OC is a mean proportional between OA and OB. For if we complete the circle and produce CO to C^1, then by Euclid III., 35, AO × OB = OC × OC^1. But OC^1 = OC by Euclid III (3) ∴ AO × OB = OC × OC or $\frac{AO}{OC}=\frac{OC}{OB}$.

Notice further, that if (fig. 141) OA, OC be given, the point B is easily found. For by Euclid III., 31, the angle in a semi-circle is a right angle. We have, therefore, only to join AC and draw CB ⊥ AC to cut AO produced, at B. Similarly draw BD ⊥ BC or ∥ AC to cut CO produced, at D. Thus a series of points on radii at right angles can be obtained. But points so obtained may be too far apart for drawing the curve with anything like accuracy. This can easily be remedied by finding a series of intermediate points in the same manner at those first obtained. Draw radii at 45° with those first drawn, and obtain OA^1, OC^1 as mean proportionals between OA, OC, and OC, OB respectively.

In explanation of the term "equiangular," as applied to the log. spiral (1) by definition, the angle of the revolving line increases by equal increments for radii in G. P. The radii are thus at *equal angles.* (2) Since OA : OA^1 : : OA^1 : OC (fig. 141), it follows by Euclid VI., 5, that the triangles OAA^1, OA^{1}C, &c., are *equiangular.* Since, therefore, the lines joining the extremities of consecutive radii make *equal angles, e.g.,* ∠ * OAA^1 = LOA^{1}C, we can, if two radii and the angle between them be given, find a third. Thus, with OA and OA^1 given at angle AOA^1, C can be found by making ∠ A^{1}OC = ∠ AOA^1 and ∠ OAA^1 = ∠ OA^{1}C. (3) But the chief characteristic, from which this spiral gets the name *equiangular*, is that the tangent at any point and the radius vector meet at a constant angle.

FRICTION-BRAKE DYNAMOMETERS.

At the ordinary meeting of the Institution of Civil Engineers, held on Tuesday, the 13th inst., a paper was read by Mr. Worby Beaumont, M.Inst.C.E., on "Friction-brake Dynamometers."

The author stated that the indications of any apparatus depending on friction must be as variable as the causes of friction and the conditions affecting it, and hence the value of the measurements obtained by means of a friction-brake dynamometer must depend on the completeness with which these causes and conditions were taken into consideration or were eliminated. In a friction brake, the causes of friction were similar to those which generally obtained in other applications of materials brought into rubbing contact; but the conditions were more variable, and chiefly due to variation in pressure and in lubrication, both being affected by the rate of work-absorption and temperature. The friction-brake dynamometer, in nearly all its forms, was essentially that devised by Prony. In it the friction between a system of wood blocks and the surface of a wheel, rotated by the motor whose power was to be measured, was employed in maintaining a weight, suspended at a point on a horizontal line, level with the centre of the wheel. For most practical purposes this brake was capable of sufficiently exact determinations of power, ranging from 5 to 200 H.P., but it presented some of the elements of inaccuracy which pertained to the friction type of absorption dynamometers, especially when used for the measurements of variable powers. For measuring the power of a motor, capable of running at a uniform speed with a constant load, the inaccuracy of its indications might be very small, and often quite insignificant. With a truly circular wheel and uniform turning power, this brake gave very nearly accurate results, provided the lubrication was regularly maintained; but slight variations in this respect, due to variation in quantity, quality, and temperature of the lubricant and rubbing surfaces, made it difficult to keep the tension of the strap in strict accord with the total friction necessary to maintain the load at a constant level. The frequent change of this tension by the screws, for the purpose of meeting these variations, introduced further inaccuracy.

A simple form of friction brake, much used as a dynamometer for testing engines by running them against a known load, consisted simply of a thin iron or steel strap, or a pair of straps, to which were attached a number of blocks of wood. A hook was fastened to the straps for the suspension of the load, and the ends of the strap were connected by a right and left-handed screw for the adjustment of the tension on the strap or pressure of the blocks upon the wheel, so as to obtain the necessary frictional grip to carry the otherwise unsupported load. With a truly turned wheel, and with uniform lubrication, this brake would run for hours with a variation of but a few inches in the level of the load, if the engine was of good design and had a proper flywheel. The variations, from several causes, were, however, sufficient to make adjustment by the hand-screw necessary, sometimes frequently. The errors in estimating the work done by the engine, which resulted from these causes, were generally small; but it was desirable to remove them for very accurate tests. It had been with this object that devices for automatically varying the tension in the belt with the variation in the total friction had been introduced. At an early date, a brake wheel, with an internal water channel, was used to avoid the mechanical difficulties which resulted from the heating of the brake wheel, and the variations due to the heating of the lubricant.

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* ∠, Angle.

One form of automatically adjusting or compensating brake suitable for small powers was due to Mr. Deprez. A simple self-adjusting brake dynamometer had been devised by Mr. J. Imray, M.Inst.C.E. In this the compensating action was due to the increase in total friction which accompanied increase of circumferential surfaces in contact. A modification of this brake consisted simply of a belt provided with wood blocks, but bearing only on the upper half of the circumference of the wheel. At one end of the strap was the load to be lifted by the motor, and at the other end was a spring under sufficient tension to give rise to enough friction to enable the motor to lift the load. This arrangement was very simple and useful.

One of the best known friction-brake dynamometers, fitted with a compensating device, was that designed by Mr. C. E. Amos and Mr. Appold, used for the larger powers by the Royal Agricultural Society. Besides the hand-adjusting screw, it was provided with a compensating lever, by means of which the rise or fall of the load was attended with a decrease or increase in tension on the brake strap, so that a position of equilibrium was automatically attained without causing inaccuracy in the indications. The compensating action could not, however, come into play except by the rise or fall of the weight from its proper position, and hence the value of the device was confined to its power of limiting that rise and fall. In practice, generally speaking, the adjustment required by means of the screw was as necessary with the compensating lever as without it, and its value might therefore be questioned for this reason alone. A further objection to this compensating lever was that it introduced an element of error, which must be variable almost directly, in proportion to the extent to which the lever came into play. With a heavily loaded brake the error must exist, and with a lubricant which materially lessened the total friction of the wood blocks upon the wheel, it must amount to a considerable part of the whole indicated power, unless adequate allowance was made for it. This allowance has seldom been made.

In a better form of compensating brake, designed by Mr. Balk, and used by Messrs. Ransomes, Sims, and Jefferies, the compensating lever was outside, instead of within, the circumference of the brake strap. It connected the ends of the strap, and to its outer end was suspended a scale pan, and a weight sufficient to keep the lever floating. This weight became a measure of the tension upon the belt, at least at the parts to which it was attached; but it must be varied with change of condition of the brake blocks, the lubricant, and the temperature of the blocks and wheel; and it must be taken as acting in favour of the motor. The great advantage of this brake was that the experimenter could always ascertain the actual load, although the tension lever acted as a compensating lever. There was considerable variation in the scale weights with the same gross load. This, Mr. H. A. Byng explained, was due to the heating of the brake wheel. When much heated, more grease had to be used, and in consequence the coefficient of friction was reduced, and the weights in the scale had to be augmented to give more tension in the brake straps. Figures given appeared to show that the larger the number of revolutions the smaller the tension for a given total friction, and this inference was supported by experience. Mr. Byng had found that with the higher speeds less weight was required on the scale for a given load, or the higher the speed the less the necessary tension in the brake belt. By the Balk brake the tension at the ends of the brake belt was measured directly; and for accurate trials a higher speed was preferred with less gross load, and with a scale weight below 7lb.

A water-cooled brake was used by Messrs. Richard Garrett and Sons. The wheel was 5ft. in diameter, and 11in. wide between the flanges within which the wood blocks ran. An annular trough was formed by internally projecting flanges 3·5in. in depth. The straight form of Appold compensating lever was employed, though under conditions which seldom, if ever, brought it into play sufficiently to affect materially the accuracy of the indication of the brake. Experiments with this brake showed that the water evaporated in the wheel represented thermodynamically 71 per cent of the mechanical work done.

A brake used by Messrs. J. and H. McLaren had been devised by Mr. Druitt Halpin, M.Inst.C.E. In it the brake wheel was 5ft. in diameter, and 7in. in width. Water was constantly supplied to the trough, and constantly taken away by a scoop pipe.

Reference was made to a simple form of friction-brake dynamometer proposed by Professor Thomson, consisting of a cord or rope passed over the upper half-circumference once, or taking one complete turn round a smooth wheel, the one end carrying a load and the other attached to a spring balance, the rope bearing directly upon the wheel without the intervention of blocks. This brake worked exceedingly well for small powers, and there seemed to be no reason against its use for large powers if a number of separate ropes were used. All the ropes might be attached to a cross-head at either end, from which the weight would hang, and to which the spring balance could be attached.

During recent trials of gas and steam engines, under the auspices of the Society of Arts, Professor Kennedy used two hemp ropes, about 1¾in. in circumference, passed once round the flywheel of the engine under trial, and these absorbed 20 H.P. a water-trough wheel being employed, and very little unguent. As a convenient means of comparing the relative capacity of these brakes, judging by the amount of work for which they had been designed, or to which they had been put, a coefficient $K = \frac{WV'}{HP}$ might be employed, W being the width of the wheel in inches, and $V' =$ the velocity of the periphery of the wheel in feet per minute. This gave for the

Royal Agricultural Society's single brake $K = 824$.
" " " treble " $K = 495$.
Garrett's water-cooled brake............... $K = 740$.
Ransome's Balk's brake..................... $K = 1020$.

Compared in this manner, the Prony brake, described by Professor R. H. Thurston, as devised for measuring a maximum of 540 H.P., the wheel being 5ft. in diameter and 2ft. wide, and $N = 100$, gave $K =$ only 75. This brake was stated to have been freely lubricated with beef tallow, plumbago, and lard oil, and although designed for a maximum of 540 H.P., it did not appear to have worked above 200 H.P., and at this power $K = 188$. The determination of the diameter and width of a brake wheel, for a given power, was often affected by prior fixed circumstances and conditions; but experience led to the conclusion that a somewhat greater width of wheel than had commonly been used for the higher powers was advisable. Taking the Royal Agricultural Society's single-wheel brake, for width, $W = \frac{KHP}{C'N} = \frac{824 \times 20}{15{\cdot}7 \times 150} = 7$ inches, C′ being the circumference of the wheel; but if the compensating levers were not used, a rather larger power might be measured on this brake. Using the proposed constant for long runs, $K = 900$, with a diameter of wheel remaining the same—*i.e.*, 5ft.—W would according to the above $= 7{\cdot}6$ inches. The author then proceeded to investigate the tension in the brake strap, straps, or belt, and the pressure upon the wood blocks, and considered the effect of the introduction of the Appold compensating lever, with the object of ascertaining whether it was a desirable feature or not. Some information on this point obtained by Messrs. McLaren was cited, and the paper concluded with an investigation on this subject, for which the author was indebted to the consulting engineers of the Royal Agricultural Society of England.

TORPEDO BOATS FOR INDIA.

On Tuesday, the 13th inst., an official trial was made in the estuary of the Thames, below Gravesend, of the last of three torpedo boats which have recently been built by Messrs. Thorneycroft and Co. for the Indian Government, and resulted in the attainment of the remarkable speed of 23¼ knots per hour. The manner in which the boat threaded her way among a mass of barges, sailing vessels, and steamers as she passed through the pool on her way to the place of trial was the subject of much complimentary remark.

On arriving below Gravesend the vessel was started at full speed, and run continuously for two hours, while at intervals during that time runs were made on the measured mile in the Lower Hope in accordance with the Admiralty practice, the results being as follows: Mean pressure of steam, 204·6lb. per square inch; air pressure in stokehold, 1¼in.; vacuum, 25½in.; revolutions, 395 per minute; and mean speed, as already stated, 23·25 knots—a result which was considered eminently satisfactory, seeing that the vessel was carrying a load of nearly 20¾ tons, and that the contract speed was only 22 knots.

A series of formal experiments were afterwards made to test the turning properties of the vessel, with both steam and hand-steering gear, the result being that in going ahead the vessel turned within a radius of her own length, while in going astern the radius was even less.

The remarkable manœuvring qualities shown on this occasion are due to the fact that the boat, like all those built by Messrs.

Thorneycroft and Co., is fitted with their patent double rudders, one on each side of the propeller, a device which has the additional advantage of affording protection to the propeller against floating obstructions.

The most interesting feature of the vessel, however, to the mechanical engineer was the performance of the "Thorneycroft" patent multitubular boiler with which she is fitted. Briefly, these boilers consist of two water chambers at the base of the boiler, and a combined water and steam reservoir at the top. This upper chamber is connected with the two lower water chambers by means of two welded steel tubes of large diameter, and by considerably over 1,000 tubes of smaller diameter. These latter are the steam generating tubes, through which, on the application of heat, the water and steam contained in them are driven with great velocity into the upper part of the upper chamber; there, by means of a separator plate, the water is separated from the steam, and passes, by means of the two large tubes already mentioned, back to the lower chambers, to be again driven up through the small tubes into the upper chamber. From this it will be seen that a most energetic circulation is going on all the time that the boiler is in action, which circulation, seeing that the steam is carried with the water, is equivalent to a very large area of water surface in an ordinary boiler, and prevents all priming.

It is claimed on behalf of these boilers that steam can be raised in them in the ordinary way within fifteen minutes from the time of lighting the fires, and that when the fires are under way it is only a matter of a few minutes to raise the pressure to any required amount, and to maintain it simply by regulating the air pressure in the stokehold. It is further claimed that, with all this, there is no symptom of leakage in the tubes or in any part of the boiler, either while the steam is being maintained at or near a constant pressure, or, unlike the locomotive boiler, when the pressure has been largely lowered or the boiler put out of use entirely. Another advantage of these boilers is that, owing to their lightness as compared with the locomotive boilers, two of these boilers may be fitted in a torpedo boat instead of one of the locomotive type, thereby effecting a considerable saving in weight. The boilers are of such a power that if one is disabled the other is sufficient to keep the boat going at three-quarters of the full speed.

LIFTING GIRDERS AT PARIS EXHIBITION.*

The first girder, forming a rib of the roof for the palace of machines, was erected on April 20th, 1888. This building is constructed with twenty large girders, each forming an arched rib of 377ft. span, rising to the height of 147⅔ft., and resting, at each end, on a cast-iron pivot at the ground level, the two halves being joined at the summit by a cast-steel pin. The ribs are placed 70½ft. apart, except at the centre and the two ends, where the spaces are 86½ft. and 83ft. respectively. Half of this building is to be erected by the Fives-Lille Company, and half by the Anciens Établissements Cail Society. The first company has already completed the erection of two ribs, which it has performed in three operations, by the help of three large scaffoldings moving on rollers, the two outer ones being 98½ft. high, and the central one 197ft. high. The pillars of the girder, each weighing 45 tons, are first lifted, turning on a special pivot, by the help of a very powerful winch, placed at the base of the central scaffolding. The adjacent pieces, weighing only two or three tons, are lifted by movable winches on the top of the outer scaffoldings. The central portion, 282ft. long, and weighing 80 tons, is lifted gradually from below, in about three hours, by four powerful winches, one under each outer scaffolding; and two under the central scaffolding. When the central pin connecting the two parts of the central portion has reached its exact position, each part is slightly turned on the pin till its lower end attains the position where it is to be joined to the erected portion. The other company will not rivet together the portions of the ribs on the ground before erection, but will rivet together separate pieces, not exceeding three tons in weight, on the scaffolding; so that the two systems of erection are essentially different.

Munificent Bequest to the Society of Civil Engineers. At the ordinary meeting of this institution on Tuesday, the 13th inst., the President announced that Lord Armstrong, in the belief that the benevolent fund connected with that institution was not adequately supported, and that it needed support, had most generously offered to contribute any sum not exceeding £5,000, provided the members of the institution would themselves raise a similar amount.

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* Foreign Abstracts, Proc. Inst. C.E.

CORRESPONDENCE.

We do not hold ourselves responsible for the opinions of our Correspondents.

TRIPLE-EXPANSION MARINE ENGINES.

To the Editor of "The Practical Engineer."

Sir,—The impression conveyed by your note on the conversion of the engines of the Union Steamship Co., in last week's issue, is that Messrs. J. and J. Thompson, Glasgow, have converted all their engines. Owing to price they have obtained the contract for the last two vessels which the company have decided to triple, and which are now *being* altered; but it was Messrs. T. Richardson and Sons, of Hartlepool, who converted the ten of which you speak (this includes one new set), and to them is due the credit of making the tripled engines so successful with respect to economy in consumption, which you quote. I may also add that there has been an increase in power, so that the Tartar has made the fastest passage from the Cape. Trusting you will make this correction, I subscribe myself,

Nov. 19th, 1888. Honour to Whom it is Due.

BRAKE TRIALS OF ENGINES.

To the Editor of "The Practical Engineer."

Sir,—I notice from your last issue that Mr. Anderson has prepared a memorandum to the engineers' report on the engine trials that took place at Newcastle last year. The first paragraph in the memorandum corrects a very obvious mistake in the report respecting the way the results were reduced for comparison, or rather in the fact that the results were not reduced. Suppose two boilers, one working at 70lb. pressure and the other at 120lb. pressure, are evaporating precisely the same amount of water per pound of coal, the former, according to the engineers' report above referred to, was working just as economically as the latter, whereas it is doing no such thing. The temperature of the steam in the first boiler is 316 deg., and in the second 350 deg.; and if the feed water enters at a temperature of 86 deg., we see that while one boiler raises its water 230 deg. only, the other heats its water 264 deg., and therefore approximately does 15 per cent more work. Fortunately, for the credit of R.A.S.E. trials, the simple engines that were compared with each other were working pretty much at the same pressure, and so the relative performances would not be materially altered by making the correction required, but the actual performances, good as they were, will be seen to be more surprising still, and reflect the highest credit on the several makers of the engines concerned. The same remark applies to the compound engines. When we compare the performances of the compound engines with those of the simple engines from the figures given in the report, then the comparison becomes most unjust and unfair to the former class to the extent of 15 per cent, or thereabouts, as shown above. It may interest your readers to know that the error was first pointed out in *The Practical Engineer*, on page 524 of your issue for Nov. 25, 1887. Mr. Anderson is quite justified in pointing out that, after all, there are certain factors in the working of a steam boiler that cannot be taken into account in a calculation, and that, if known, would alter the perspective, so to speak; but this, surely, is no reason for ignoring important matters that can be taken into account, and giving us something instead that isn't true, and that vitiates the whole result.—I am, &c.,

Manchester, Nov. 19. Geo. Harrison, M.Inst.M.E.

QUERIES AND REPLIES.

Horse Power of Gas Engine.—Will some reader kindly afford me full information as to how I can obtain the horse power of a gas engine?—G. B.

Answer.—Work out exactly the same as in the case of a steam engine, but mind and only count the *effective* piston speed of engiue, for no engine in the market ignites twice every revolution. Take the "Otto" compression engine for example. The "cycle" is this: (1) Out-stroke, drawing in gas and air charge; (2) in-stroke, compressing charge just drawn in; (3) out-stroke ignition; (4) in-stroke, expelling products of combustion, or two revolutions to each ignition. Of these only *one* stroke *produces* power; all the other three are termed "pumping strokes," and absorb it. Take an Otto engine, 10in. diameter of piston, 18in. stroke, 160 revolutions per minute: Take mean pressure by indicator card exactly as in case of a steam engine, = say 25lb. per square inch. If working at full power, effective piston speed $= \frac{160}{2} \times 1{\cdot}5 = 120$ft. per minute, and H.P. $= \frac{78{\cdot}5 \text{ sq. in.} \times 120}{33{,}000} = 2{\cdot}85$. From this you must deduct the H.P. absorbed in drawing in and compressing the charge. The reason for compressing is that a highor pressure can be obtained, and consequently a higher range of expansion obtained—G. T. Pardoe.

[We have received another answer to this query, but are compelled to hold it over in order to prepare an illustration by which it is accompanied.—Ed.]

Plumbago Crucibles.—I should be obliged if some correspondent would kindly inform me what is the composition which is used in the manufacture of black lead or plumbago crucibles.

Answer.—"Berlin" crucibles are made of eight parts Stourbridge clay, three parts old crucibles finely ground, five parts coke, and four parts graphite or "blacklead." "Blacklead" crucibles consist of one part fire-clay and two parts of graphite.

Answer.—In reply to "Plumbago Crucibles," the best crucibles are formed from a pure fire-clay, mixed with finely ground *cement* of old crucibles, and a portion of blacklead or graphite; some pounded coke may be mixed with the plumbago. The clay should be prepared in a similar way as for making pottery ware; the vessels after being formed must be slowly dried, and then properly baked in the kiln. Crucibles formed of a mixture of eight parts in bulk of Stourbridge clay and cement, five of coke, and four of graphite, have been found to stand 20 settings of 76lb. of iron each. Such crucibles resisted the greatest possible heat that could be produced, and bore sudden cooling without cracking. Another composition for brass-founding crucibles is the following: $\frac{1}{2}$ Stourbridge clay, $\frac{1}{4}$ burned clay cement, $\frac{1}{8}$ coke powder, $\frac{1}{8}$ pipe-clay; the pasty mass must be compressed in moulds. Blacklead crucibles are made of two parts of graphite and one of fire-clay, mixed with water into a paste, pressed in moulds and well dried, but not baked hard in the kiln. They bear a higher heat than the Hessian crucibles, as well as sudden changes of temperature, have a smooth surface, and are therefore preferred by the melters of gold and silver.—G. A.

Combining Indicator Diagrams.—Can any of your readers recommend me a book on indicator diagrams, from which I can obtain information concerning the combining of indicator diagrams of triple-expansion engines?—Sheerness.

Answer.—You will find full information regarding the matter in two articles dealing specially with the subject, which appeared in our issues of September 28th, page 460, and October 19th, page 500.

Bronzing Iron and Steel.—Would some reader of your valuable paper kindly furnish me with a recipe for bronzing iron and steel?—Driver.

Answer.—The article must be chemically cleaned up, brushing with a mixture of fine pumice in dilute sulphuric acid, rinsed in pure water and dried. The bronze liquor must be applied quickly and evenly with a camel's hair brush, having first heated the article just so that it can be held without burning the fingers.

No. 2.—A thin coating of bronze powder can be spread over the surface of the material to be ornamented by either applying it directly upon a coating of various sizes, or by mixing with a vehicle of gum-arabic or transparent varnish. The latter is most desirable, as in the other case, being subject to the direct action of the atmosphere, the bronze powder soon tarnishes. Many preparations are used as vehicles, such as transparent varnish thinned with turpentine, gum-arabic dissolved in water, and gold size reduced with parchment size. There are a variety of colours in bronze powders, and to produce the best effect the size or vehicle should be of a colour similar to that of the bronze used. In gold size the colouring pigment is ochre, and in its place for green bronze, red bronze, or blue bronze may be employed respectively verditer, vermilion, or Prussian blue—a very small quantity being sufficient. In bronzing on painted work, the ground should be as nearly as possible the colour of the bronze to be applied.

No. 3.—Dissolve gumlac in four parts by volume of pure alcohol, and then add bronze or any other metal powder in the proportion of one part to three parts of the solution. The surface to be covered must be very smooth.

No. 4.—Another method is to coat the object with copal or other varnish, and when this has dried so far as to become "tacky," dust bronze powder over it. After a few hours the bronzed surface should be burnished with a burnisher of steel or agate.

No. 5.—According to the experiments of Dr. B. W. Gerland, metavanadic acid may be used in the preparation of a substitute for genuine gold bronze. If a solution of sulphate of copper and salammoniac is mixed with vanadiate of ammonia and cautiously heated, there is obtained a compound of a splendid gold colour, which is deposited from the liquid in the form of gold coloured spangles. These admit of being readily ground up with gum and varnishes, cover well, do not change on exposure to air, and are in every respect equal to genuine gold bronze. Vanadium yields also a series of very fine colours, especially adapted for painting on porcelain.—Draughtsman.

Answer.—If you will state what the articles are you wish to bronze, I will be glad to assist you. Are they gun barrels? If so, state in next week's, and I will forward recipe.—Fabricant d'Armes.

Answer.—In reply to "Driver's" inquiry, as to bronzing iron and steel, the best and most rapid bronzing liquid, which may be applied to copper, brass, iron, &c. with equal advantage, is a solution of the chloride of platinum (nitro-muriate of platinum), called chemical bronze; but it is expensive. With it almost any colour can be produced, according to the degree of dilution and the number of applications. If "Driver" would give some idea of the kind of colour, whether antique bronze, or new bronze, or whether browning, as of gun barrels, &c., is what he wants to do, it would be possible to give him a further answer, more to the point.—G. A.

Incrustation in Surface Condenser's Tubes.—Can any reader inform me how to remove the incrustation from the inside of the tubes of a surface condenser of a land engine? The deposit is very hard and tenacious, and consists almost entirely of carbonate of lime.—Nemo.

Answer.—Perhaps the following will assist "Nemo." The condenser tubes of a vessel after stranding were found, while overhauling, to be coated about $\frac{1}{16}$in. thick, the incrustation being so hard that it could scarcely be cut with a knife. The tubes were gently heated, and tapped with a wood mallet, with perfectly satisfactory results.—Orion.

Answer.—If "Nemo" will communicate with Mr. C. Trounsell, chief engineer, steamship Jane Bacow, Liverpool Wharf, Broad Quay, Bristol, he will no doubt get the information required.—Anon.

Hydraulic Ram.—Can any reader oblige me with a sketch and rules for proportioning a modern hydraulic ram, such, for instance, as the "Galihan" ram? I have studied the description of the hydraulic ram given in Rankine's "Prime Movers," but the sketch there given is very obscure, and I cannot follow the action of the waste water valve.—Querist.

[The answer to this query is being held over in order to permit an illustration to be prepared.—Ed.]

Joy's Valve Gear.—I hope the question of "G. H." regarding Joy's valve gear will be fully answered, and if you could accompany the answer with a sketch it would, I think, be of interest to a many of your readers.—Japan.

Joy's Valve Gear.—Can any of your readers tell me how the valves are set in an engine when Joy's valve motion is adopted? Also, how to get the lead of valve? Suppose a valve to have $\frac{1}{8}$in. lead, and it is desirable to increase it to $\frac{3}{16}$in., how would you operate?—G. H.

Diagram of Stress for Girder.—I should be obliged for any information regarding the most correct method of setting out a parabola for a uniformly-loaded straight girder, supported at both ends, showing line of stress and how to fix length of plate by same. One method I know is to draw the flange plates full size vertically, and make the central vertical line equal to the height thus obtained. But is there not another method of setting up the centre vertical line by taking the areas of the plates and angle irons consecutively?—Gyrtona.

[We have received an answer to this query, but are compelled to hold it over to prepare the illustration with which it is accompanied. We hope to give the answer next week.—Ed.]

Weighing Machines.—Is there any book published dealing specially with the construction of these machines, and what is the price?—T. D.

Chilled Furnace Bars.—Can any of your readers give me any information with regard to chilled furnace bars? To what depth can they be chilled from the top surface? Is it difficult to cast chilled bars any length—say 6ft.? What difference does it make in the nature, temperature of fusion, and also cost as compared with ordinary furnace bars?—Durability.

Specific Gravity of Sea Water.—I should feel much indebted for assistance from you or any of your numerous readers with the following question: A vessel, consisting of a pipe closed water-tight at each end by pistons, which slide inside the pipe, thereby increasing or diminishing the total volume, floats $\frac{8}{10}$ vol. submerged in sea water, when expanded to its greatest extent. By the addition of a certain quantity of sea water the vessel is sunk just under the surface of the water. By means of the pistons its volume is now diminished, causing it to sink. Required, the proportion of this diminution to the total original volume per 100 fathoms sink? Also, How does the specific gravity of sea water vary on an average with the depth from the surface, and between what limits?—Janey.

I beg to thank "W. A." for his offer of assistance in my problem. I think, however, he misunderstands my question, which in substance is simply, What variation in the *specific gravity* of my vessel must I make in order that it may float at different depths *under* the surface? I simply gave a pipe expanded or diminished by pistons as an example.—Janey.

Setting Slide Valves of Marine Engine.—Previous to setting the slide valves of a marine engine it is customary, in the shop in which I am engaged, for those in charge to ascertain from the draughtsman the position of the eccentric sheaves on the shaft or coupling. The sheave is then temporarily fastened by set-screws, as it is sometimes apt to be moved slightly when the valves are being set. The instruction is to keep the sheave a stated distance or height from the shaft or coupling. A surface gauge is generally applied from the keep of the main bearing brasses, the difference of height from the coupling being taken into consideration. Will some reader enlighten me on this method; on what principle is it based?—Primrose.

Paper Machinery and Manufacture.—Can any reader inform me whether there are any books published on the manufacture of paper and paper machinery, also the name of the publisher and price?—Boiler.

Deterioration of Coal.—Could you or any of your readers tell me how much coal deteriorates by being stacked?—Xerxes.

Pitch Striker for Screws.—Will someone be kind enough to favour me with instructions for making a "pitch striker," or where the tool can be bought? The use of the tool is to obtain, with certainty, a true thread by the ordinary hand chaser.—A Fitter.

"Griffin" Gas Engine.—Will anyone who has had some experience with one of these gas engines kindly give me a few hints as to the management and cleaning of it? Also what number of lathes, 6in. centre, slotting and milling machines, I may work with a two H.P., without putting too great a strain upon it? What is the estimated consumption of gas per day of eight hours? Having lately purchased one, any information on the above points will be gratefully received by Fabricant d'Armes.

Ventilation of Mine.—Having noticed the questions and answers of "T. H. A." and "H." in *The Practical Engineer* of November 9th, regarding compressive ventilation of mine, may I ask how is this effected in the compressive system? Do they close the down-cast shaft at the top, and what kind of a fan do they use? Are there books on the compressive ventilation system?—Important.

TO CORRESPONDENTS.

Boiler.—We do not know of any book dealing specially with the subject you refer to, but you will observe we have inserted your query, which may possibly elicit some information.

W. S. H.—We have not the exact address of Mr. Baillie Wallace, the chairman of the Glasgow Engine-keepers' Association, but we do not doubt if you address him simply at Glasgow it will find him, or if you communicate with Mr. R. D. Munro, the chief engineer of the Scottish Boiler Insurance Company, Glasgow, he will probably be able to furnish you with full information.

G. T. Pardoe.—We note your complimentary reference to the enlargement of the journal, and for your information, as well as that of other readers who wish to complete their sets for binding, we may say that copies of the back numbers of *The Practical Engineer* may be obtained from our office.

W. Pearce.—Thank you for your commendatory letter regarding the alteration of the journal. We trust that *The Practical Engineer* in its new dress will please you. We may say, with regard to its circulation in London and district, that it already amounts to several thousands weekly. Complaints have been made to us at various times as to the difficulty in obtaining it, and it will be of assistance to us if our readers would kindly communicate with us, informing us when and where this occurs.

Orion.—Thank you for your complimentary references with regard to our enlargement. The many letters we have received from our readers and friends, written in a similar vein, have been most gratifying. Your suggestion with regard to the numbering of the queries, for greater convenience of reference, is an admirable one, and we shall certainly adopt it in our next volume, commencing in January. We are preparing a careful index of all the queries that have appeared this year, which will, no doubt, be of great convenience. The index issued with our last volume was far from being as full and complete as was desirable, but it was prepared very hurriedly, and under great difficulties. We think, however, our readers will have no complaint to make on this score with regard to the one now being compiled.

Anxious.—Your query is hardly a suitable one for our columns, besides which, we strongly object to respond to any inquirers who refrain from giving their name and address.

B. F.—You will find an answer to your inquiry in a footnote to the article on collapsing pressure of vertical fire-boxes on page 558.

W. Gill.—We feel some difficulty in answering your question. Your salary will depend to a large extent on circumstances. From your age, you cannot have had much experience, and the value of your services will, in the open market, depend very much on that. If we have to offer you any advice at all, it is to get experience; never mind salary at present.

MISCELLANEA.

Ship Canal for Sheffield.—A company which has for its object the construction of a ship canal connecting Sheffield with the sea was registered on Saturday last.

The Salt Union.—It is reported that the Salt Union has acquired the property of Messrs. Bell Brothers, at Port Clarence, Middlesbrough, thus removing a source of competition and completing the monopoly of the salt trade in that district.

Liverpool Waterworks.—At a meeting of the Liverpool Water Committee on Monday, the Chairman said that the new works at Vyrnwy were now approaching an interesting point, as they hoped shortly to begin impounding the water, when the beneficial results of the work, which had been in hand for several years, would be seen.

Serious Charge against the Halifax Gas Manager.—On Tuesday last, Mr. William Carr, late gas manager for the Halifax Corporation, was arrested at his home, on a charge of having, on or about the 28th of September last, unlawfully, and with intent to defraud, mutilated a certain book belonging to the Halifax Corporation. The case was adjourned, the prisoner being admitted to bail.

Important Discovery of Salt.—It is stated that Messrs. Brunner, Mond, and Co. Limited, the alkali company of Northwich, have discovered a supply of brine at the Anderton works capable of making several hundred thousand tons of salt per annum. This firm is at present the only powerful brine-pumping competitor of the Salt Union in Great Britain. The struggle between these two great concerns, if it becomes active, will be watched with interest.

Large Shear Legs.—Messrs. J. and G. Thomson, of Clydebank, are now engaged in erecting in their shipbuilding yard a pair of enormous shear legs, said to be the largest in the world. The legs are of steel ⅞in. thick, closely riveted, and strengthened in various ways. They are of great length, and weigh some 112 tons. The whole work of construction has been carried out at the Clydebank yard, the steel castings being supplied by the Steel Company of Scotland.

Miners' Wages.—The dispute between the iron miners employed by the Barrow Steel Company in their Furness mines, which at one time threatened to terminate in a strike, has been settled. The men asked for an advance equal to 12½ per cent, but this was refused. They then gave a week's notice. The notice was found to be illegal, and at a mass meeting of the men it has been decided to accept the masters' terms, the advance ranging from about 1d. to 6d. a day. The dispute affected over 2,000 men.

The North of England Iron Trade.—An arbitration to settle the rate of wages in the North of England iron trade was commenced at Newcastle on Monday last before Dr. Spence Watson. The operatives claimed an advance of 10 per cent in view of the higher prices obtainable and advances in other parts of the country. The masters replied that old contracts still kept the average price down. They had offered 5 per cent with the sliding scale, which had been rejected.

Technical School at Saltaire.—A new technical school, a memorial to the late Sir Titus Salt, was opened on the 15th instant at Saltaire by the Master of the Company of Clothworkers of London. The building is very largely in debt, and the governors are appealing for help. The Saltaire Exhibition was originated last year in the hope of defraying the cost of the new school, but as it resulted in a loss of £4,000, the financial difficulties of the governors were aggravated instead of relieved, and the building is now over £12,000 in debt.

Electric Tramcars at Birmingham.—The first public trial of electricity as a motor for tramway purposes in Birmingham was successfully made about a week ago upon the lines of the Central Tramways Company. The engine is based on the "Julien" system, which is well known in New York, Brussels, Melbourne, and elsewhere, and was built by Messrs. Elwell and Parker, of Wolverhampton. It weighs about 8½ tons, and sufficient electricity can be stored in the accumulators to enable it to perform a journey of between seventy and eighty miles. The engine is said to be capable of developing 40 I.H.P.

Awards of the Royal Society.—The Copley medal of the Royal Society has this year been awarded to Professor Huxley, in recognition of his recent investigations, and for his services to biological science in general during many past years. The Rumford medal is to be given to Professor Tacchini, for his researches in solar physics, and the Davy medal to Mr. Crookes for his researches on the electric discharge in high vacua. The Queen has approved the award of the Royal medals to Baron Ferdinand von Mueller, the Australian botanist, and to Osborne Reynolds, professor of engineering, Owens College, for his researches in mathematical and experimental physics.

Legislation for Storage of Petroleum.—The Home Secretary, in replying to a question by Lord H. Bruce in the House of Commons on Monday last, stated that the authorities were now engaged collecting information regarding the disastrous explosion which occurred on board a petroleum steamer last month in Calais harbour. Statutory power, he said, already existed for enabling harbour authorities to insist on valuable precautions being exercised with regard to such vessels, though he thought it desirable that these powers should be strengthened by further legislation, and he had prepared a bill for this object, which he intended to introduce at as early a period as possible.

Boiler Explosion at Chesterfield.—A vertical boiler about 4ft. 2in. diameter, and with firebox about 3ft. 8in. diameter, exploded on Friday last, at a small iron foundry at Whittington Moor, near Chesterfield. The upper part of the firebox appears to have collapsed through weakness, being constructed of light plates originally, which had become wasted during use, and the firebox being unstrengthened in any way by cross tubes or other means. Pending the Board of Trade examination, however, full particulars could not be ascertained. The cupola was only a short distance from the boiler, and the blast tenter was blown some distance, and cut about the head and severely scalded about the upper part of the body, necessitating his removal to the Chesterfield Hospital. The foundry foreman was also somewhat scalded about the arms.

Some Difficulties of Railway Construction in Japan. From the report of the Japanese Railway Bureau for the past year, which has just appeared, it would seem that, rapidly as it is progressing, railway construction in that country has to meet unusual difficulties, or rather an unusual number of difficulties, owing to the physical geography of Japan. One line of 205 miles in length involves the construction of 16 tunnels, 16,000ft. long, and the bridging of 11 rivers. One of these has a velocity in time of flood of 27ft. per second, and in another the brick piers have to be sunk to a depth of 80ft. A range of mountains is crossed at a height of 1,468ft. Part of another line ascends to a height of 3,144ft., and during five months of the year work is rendered impossible by the snow, and sometimes in the summer months an epidemic of cholera has the same effect.

Society of Arts.—The one hundred and thirty-fifth session commenced on Wednesday, November 21, with an opening address by the Duke of Abercorn, C.B., chairman of the council. Previous to Christmas there will be four ordinary meetings, in addition to the opening one. At the first ordinary meeting of the society a paper will be read by Colonel Gouraud on "The Phonograph." This will be followed by one of Mr. Henry Edmunds on "The Graphophone." At the other two meetings to be held before Christmas the papers will be by Mr. W. H. Deering on "Explosives," and Mr. W. J. Dibdin on "Standards of Light." Among the papers announced for the latter part of the session may be mentioned—"Manufacture of Sèvres Porcelain," by Mr. E. Garnier (director of the Sèvres Manufactory); "The Forth Bridge," by Mr. Benjamin Baker; "The Channel Tunnel," by Colonel Hozier; and "Secondary Batteries," by Mr. W. H. Preece, F.R.S. The first course of Cantor lectures will be by Captain W. de W. Abney, C.B., F.R.S., on "Light and Colour;" the other lecturers will be Mr. Alan S. Cole, Mr. W. J. Linton, Mr. Walter Crane, Mr. C. V. Boys, F.R.S., and Mr. H. Graham Harris. The juvenile lectures, at Christmas, will be given by Professor Henry E. Armstrong, Ph.D., F.R.S., the subject being a chemical one.

Society of Architects.—This society opened the winter session on Tuesday, the 13th instant, with a *conversazione*, held in the New Gallery (Arts and Crafts Exhibition), Regent Street, London. The society at present has 369 members and eleven associate members, and is rapidly adding to its numbers. The President in the course of the evening delivered his address. He congratulated the society upon the fact that none of its members were in any way implicated in the recent disclosures of the Metropolitan Board of Works. As to their profession generally, he might safely say that the labours of the past year had shown real progress in their art, and he looked forward to a better time for architecture. The present rise in prices, averaging about 12 per cent on the principal building materials, was a sign of returning national prosperity. The most important subject that could be considered was the statutory education and registration of their profession. It was an indisputable fact that the vast majority of their articled pupils left at the end of their term, knowing less about the practical side of their work than a builder's clerk, and yet very many set up in practice and completed their training at the expense of their clients' interests. He advocated the compulsory qualification of architects. The President then went on to specify the improvements which had been made during last year in building materials, mentioning as of special value the new glazed brick and terra-cotta facings, and afterwards dealt with the progress made in the supply of electric light.

The Annual Ring in Trees.—In the course of his last report, the chief of the forestry section of the Agricultural Department of the United States, referring to the annual ring in trees, asserts that these exist as such in all timber grown in the temperate zone. Their structure is so different in different groups of timber that from their appearance alone the quality of the timber may be judged to some extent. For this purpose the absolute width of the rings, the regularity in width from year to year, and the proportion of spring wood to autumn wood must be taken into account. Spring wood is characterised by less substantial elements, the vessels of thin-walled cells being in greater abundance, while autumn wood is formed of cells with thicker walls which appear darker in colour. In conifers and deciduous trees the annual rings are very distinct, while in trees like the birch, linden, and maple the distinction is not so marked, because the vessels are more evenly distributed. Sometimes the gradual change in appearance of the annual ring from spring to autumn wood, which is due to the difference in its component elements, is interrupted in such a manner that a more or less pronounced layer of autumn wood can apparently be recognised, which again gradually changes to spring or summer wood. This irregularity may occur even more than once in the same ring, and this has led to the notion that the annual rings are not a true indication of age; but the double or counterfeit rings can be distinguished by a practised eye with the aid of a magnifying glass. These irregularities are due to some interruptions of the functions of the tree, caused by defoliation, extreme climatic condition, or sudden changes of temperature. The breadth of the ring depends on the length of the period of vegetation; also when the soil is deep and rich, and light has much influence on the tree, the rings will be broader. The amount of light and the consequent development of foliage is perhaps the most powerful factor in wood formations, and it is upon the proper use of this that the forester depends for his means of regulating the development and quantity of his crop.

The Russian Cruiser Admiral Korniloff.—The new Russian cruiser Admiral Korniloff, which has been built at St. Nazaire by the Société des Ateliers et Chantiers de la Loire, has just completed her trials off Cherbourg. The Admiral Korniloff is a cruiser built partly of steel, partly of timber, with twin screws, and has a displacement of 5,000 tons. Her principal dimensions are 350ft. in length by 48ft. broad, and her draught of water does not exceed 23ft., so that she can enter almost any port. Her armament consists of 14 6in. guns, of a very new pattern, and all well protected from the enemy's fire, ten revolver guns, six guns with rapid fire, two guns for using in the ship's boats, and six torpedo tubes. The motive power consists of two horizontal engines with triple expansion, each driving one of the screws, while there are eight boilers, and four ventilators, which will keep the temperature of the engine-rooms to within 86 deg. The Admiral Korniloff will carry enough coal to enable her to steam 15,000 knots at a moderate speed, so that she would be able to go from the Baltic to China without putting in at any port. The vital parts of this cruiser are protected by an ironclad deck, while the sides are also well covered, and the coal bunkers will act as a protection for the engines and machinery. The commander's post in the event of a combat is a large ironclad block-house, in which are concentrated all the cruiser's means of action, such as the wheels of the helm, the apparatus for transmitting orders to the engine-room and powder magazines, and also the apparatus for the converging of artillery fire and the discharge of the torpedos. In short, this block-house contains all that the commander of the cruiser, aided by a few of his officers, would require for the management of his ship if engaged in combat. The accommodation for both officers and men is very spacious and comfortable, and the crew numbers over 400. The trials took place with the cruiser carrying a full cargo, and with her bunkers full of coal, the artillery being represented by an equal weight of ballast. The first trial, which lasted over six hours, resulted in a mean speed of 17½ knots, while a second trial at high pressure gave 18½ knots.

Lord Brassey on Colonial Defence.—Speaking at a crowded meeting in Liverpool the other day, Lord Brassey delivered an address on the colonies. He said that of the total amount of the cotton manufactures which we exported the colonies took £26,602,000 out of a total export of £57,376,000, while of iron and steel manufactures they took £7,728,000 out of £19,255,000. He had recently returned from a voyage especially undertaken to ascertain the condition and difficulties of Australian ports and coaling stations, on which the efficiency of the navy, as the defence for our commerce, so essentially depended. At all the points recognised by our naval and military authorities as the main coaling stations of the British navy he found the work of fortification, whether undertaken by the British or by the Colonial Governments, well advanced, if not completed. But guns were wanting everywhere. In another important particular he found a deficiency for the supply of which he had not heard as yet that any steps had been taken—he referred to the weakness of the garrisons at all the coaling stations in the more distant parts of the seas. It was obvious that the unity of the empire depended upon the free, large adoption for the distant colonies inhabited by people of the British race of the policy of self-government. We had given to the colonies the unrestricted control of their fiscal systems. It was only in their external relations that the influence of the mother country was felt, and then only as a shield and a support. It was difficult to conceive any combination of circumstances under which ties so elastic as these could be put to the risk of rupture. He made no doubt that the colonies would become more and more exacting in their demand on the mother country in relation to appointments to Colonial Government, as well as in other matters. They would ask for a more clearly defined position in the direction of external affairs, and that the officers of the imperial navy should be more largely recruited than at present by the nomination of cadets from the colonies. A judicious compliance would tend to prevent all possibility of the breaking into pieces of the British empire, a dissolution of which would be a political and a moral catastrophe which all the world would deplore.

SELECTED PATENTS.

APPLICATIONS FOR LETTERS PATENT.

November 8th.

16157 Packed Cocks, R. T. Baines, London.
16159 Frictional Paste, J. Taylor, Manchester.
16160 Relief Valves, R. Baird, Glasgow.
16164 Boilers, T. White and J. W. Innes, Sheffield.
16177 Pattern Valve, E. J. Barker, London.
16183 Gas Engines, R. Simon, London.
16201 Rotary Motors, G. H. Cawthorn, London.
16211 Bearings, W. S. Sargeant, London.

November 9th.

16216 Adjustable Spanner, J. Brawn, Birmingham.
16220 Gas Engines, J. Roots, London.
16221 Steel Bars, E. L. Ransome, London.—[Complete Specification.]
16223 Boring Tools, B. H. Bent, Cambridge.
16225 Snatch Blocks, H. Von Hartz, London.—[Complete Specification.]
16229 Water Levellers, M. Deis, Berlin.—[Complete Specification.]
16231 Cupolas, J. Hilton, London.
16232 Consuming Smoke, G. Cbatton, London.
16235 Miners' Safety Lamps, W. Patterson, Newcastle-upon-Tyne.
16239 Leather Washers, J. W. Teunaut and J. E. Hodson, London.
16241 Combing Cotton, C. Lever, Manchester. (H. Lever and R. Redford, United States.)
16246 Waste Pickle, H. J. Kirkman, London.
16249 Electric Light Switch, A. P. Lundberg, London.
16250 Spiral Springs, H. Mottershall, Manchester.
16257 Arc Lamps, C. E. L. Brown, London.
16264 Lamp Holders, G. Binswanger and H. Hirst, London.
16266 Tubular Shafts, the Mannesmann Tube Company, Limited, London. (F. Reuleaux, Germany.)
16268 Gas Engines, E. L. Lalbin, London.
16269 Taps, G. Culver, London.
16272 Ventilators, B. Holbrook, London.—[Complete Specification.]
16276 Pulverisers, C. D. Goubet, A. Schanschieff, and C. Akers, London.
16283 Valves, H. H. Lake, London. (E. Hill, United States.)—[Complete Specification.]

November 10th.

16289 Gas and Electric Meters, S. Bunting, Dublin.
16291 Turning Mill Rolls, G. Harris, Bristol.
16292 Expansion Gear, H. Kühne, London. (W. R. Proell, Germany.)
16293 Producing Blocks, P. Born, London. (A. Schimd, Switzerland.)
16294 Pumping Engines, J. Murrie, Glasgow.
16296 Cocks or Valves, S. Moorhouse, Manchester.
16299 Iron or Steel Plates, R. McKinnell, Glasgow.
16303 Duplex Engines, G. Thomson, Birmingham.
16307 Gas Valve, G. Watson, Oldbury.
16310 Steam Belts, A. Guillemet, France.
16318 Lock Nuts, R. Done, Birmingham.

November 12th.

16350 Cleaning Boilers, S. Abraham, London.
16367 Tube Scrapers, A. Bainbridge, trading as C. Topham and Co., London.
16374 Saddle Bars, H. Rees-Phillips, Middlesex.
16384 Keeping Packing, S. A. Johnson, London.
16385 Protection of Gauge Glasses, A. J. Boult, Middlesex. (E. Engels, Germany.)—[Complete Specification.]
16388 Steam Boilers, H. H. Lake, London. (W. S. Post and H. de W. Sawyer, United States.)
16396 Valves, W. H. Snelling, London.

November 13th.

16406 Rotary Engines, G. H. Weston, London.—[Complete Specification.]
16409 Fires, Furnaces, &c., E. Marsh, Leeds.
16415 Vice, W. Fox, Bradford.
16421 Gas Meters, R. Arrowsmith, trading as Stormont and Co., Birmingham.
16424 Fastening Nuts, A. Bladon and O. Bladon, Derby.
16434 Steel Packing, E. A. Slade, South Shields.
16443 Charging Furnaces, L. Johnson and J. Powell, London.
16448 Mitreing Machines, T. Smith, Middlesex.
16449 Governors, W. P. Thompson, Liverpool. (J. Rothchild, ———.)
16451 Protecting Furnaces, J. Ewart, Liverpool.
16452 Overflow Valves, J. E. Chadwick, Manchester.
16460 Purification of Water, A. Howatson and W. E. Lawrence, London.
16466 Purifying Sulphuric Acid, H. Simon, London. (Messrs. Vorster and Grüneberg and the Berlin-Anhaltische Maschinen-Vau-Actiengesellschaft, Germany.)
16470 Metal Washers. S. J. Shimer, London.—[Complete Specification.]
16474 Sand Papering, H. H. Lake, London. (The Berlin Machine Works, United States.)—[Complete Specification.]
16475 Integrating Apparatus, J. G. Lorrain, London.
16476 Carriage Bolt, H. J. Snell, London.

November 14th.

16490 Steam Boiler, M. Lawson, Newcastle-on-Tyne.—[Complete Specification.]
16505 Wheel Sinking Plate, W. Southorn, Guisborough.
16511 Screws, J. P. Vaile and J. R. Vaile, the younger, London.
16518 Lubricators, R. Baird, Glasgow.
16520 Lock Nuts, R. Hundleby, Sheffield.
16521 Valves and Taps, J. Whiteley and S. Spencer, London.
16529 Automatic Coupling, A. Buckley and I. Buckley, Manchester.
16551 Lubricators, J. S. Brandstaetter, Liverpool.
16557 Purifying Feed Water, C. J. Galloway and A. W. Galloway, London.
16562 Weighing Machinery, F. W. Cannon, London.
16563 Dye-extracting Apparatus, F. Rhodes, Huddersfield.
16567 Iron and Steel Alloyed with Nickel, H. Schneider, London.
16568 Iron and Steel Alloyed with Copper, H. Schneider, London.
16569 Steel Alloyed with Copper, H. Schneider, London.

November 15th.

16578 Steam Boilers, J. Brooke, Halifax.
16584 Force Pumps, E. A. Slade, South Shields.
16586 Smoke-consuming Apparatus, C. Womack, Barnsley.—[Complete Specification.]
16587 Steam Traps, J. S. Stubbs and S. H. Stubbs, Manchester.
16600 Making Pins, A. E. Herbert and W. S. Hubbard, Birmingham.
16605 Piston Packing Rings, J. Menzies, Glasgow.
16608 Locomotive Engines, F. W. Webb, London.
16613 Coupling, E. B. Hughes, London.
16614 Super-heating Steam. R. A. Baillie, London.
16623 Electricity Meters, L. Paris and Scott, Limited, and W. H. Scott, London.
16625 Electric Arc Lamps, E. W. Anderson, London.

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Firms replying to advertisements inserted in our columns will do us a favour by mentioning the name of this journal in their inquiries.

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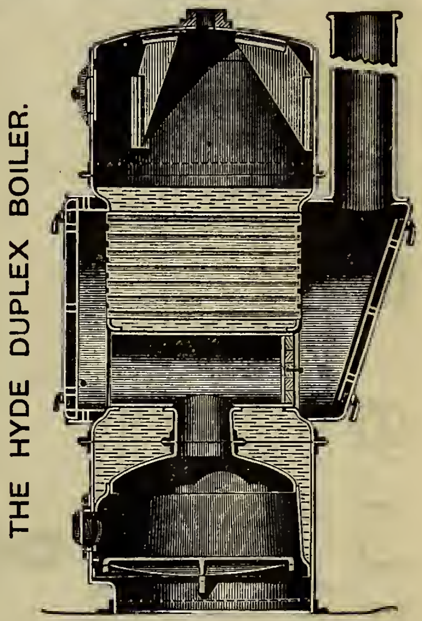

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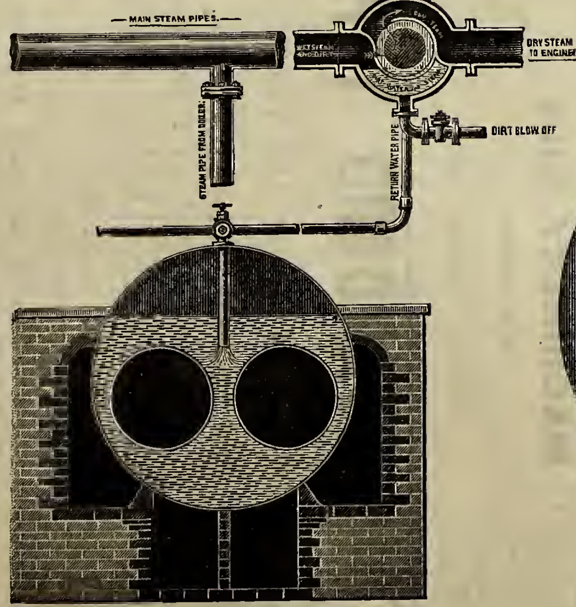

SHEWING AN ENLARGED VIEW OF SEPARATOR.

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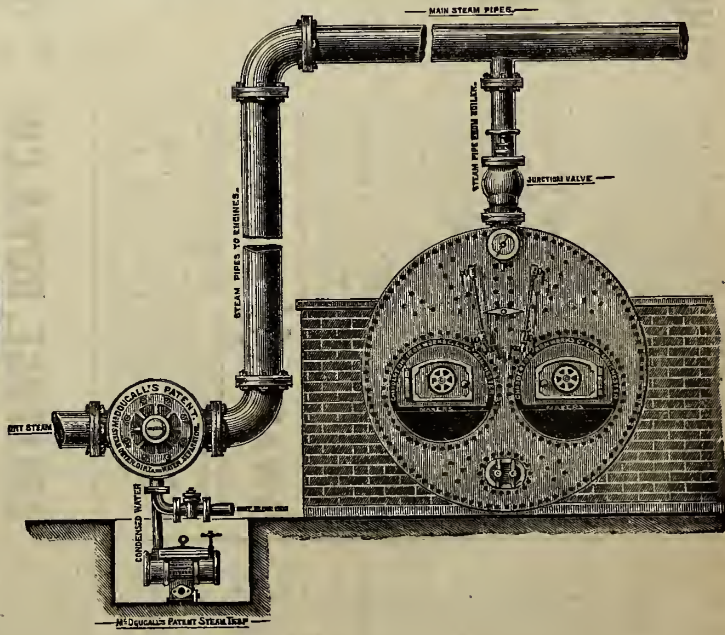

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PUBLISHERS' ANNOUNCEMENTS.

BACK NUMBERS of "The Practical Engineer," from the commencement, can be obtained at either of our Offices in London or Manchester, or by order of any Newsagent.

Vol. I. (bound), containing Nos. 1 to 44 inclusive, from March to December, 1887, price 6s. 6d., can still be obtained by order from any Newsagent, or will be forwarded, carriage paid, from either of our offices on receipt of the amount by postal order or stamps.

Numerous complaints having been made to us by Subscribers of the difficulty they experience in obtaining copies of *The Practical Engineer* in certain districts, we have to state that the Journal can be obtained by any Newsagent through the ordinary trade channels, and no difficulty should therefore exist in obtaining copies *by order* of any Newsagent.

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EDITORIAL NOTICES.

All communications for the Editor of this Journal should be addressed to 6, Victoria Station Approach, Manchester.

Communications intended for insertion in the current week's issue should reach us not later than Tuesday Evening.

We cannot undertake to return rejected manuscripts or drawings unless accompanied by a stamped and directed envelope.

Contributors are requested to write on one side only of the paper. Sketches should be sent on separate sheets.

TO ADVERTISERS.

Advertisements intended for insertion in the current issue should reach our Manchester Office on Wednesday Morning *at the latest.*

NOTICE TO READERS.

Our readers will observe that we have refrained in this issue from cutting the edges of the journal. As we explained a few weeks ago, it was quite intended to continue doing this, but it has been pointed out to us that the adoption of this course would be very objectionable to those who purpose binding the journal at the end of the year, on account of the second cutting which would thus be required, and which would render the volume somewhat unsightly. It has been thought better, therefore, as the current volume is rapidly approaching completion, to *defer the cutting of the edges until the commencement of the new volume, in January,* when special arrangements will be made to afford a margin around the text sufficiently wide to allow not only for the cutting of the edges when the paper is issued in the first instance, but also for the second cutting which becomes necessary when the numbers are placed in the hands of the bookbinder.

We may take this opportunity of acknowledging the numerous complimentary letters which we have received from our friends regarding the enlargement of the journal, and which press of other matter prevents our acknowledging individually.

THE
PRACTICAL ENGINEER.
NOVEMBER 30TH, 1888.

TECHNICAL EDUCATION.

LORD ARMSTRONG'S REPLY.

Lord Armstrong has replied to his critics in the current number of the *Nineteenth Century*, and, as we think, most unanswerably. His remarks are called forth chiefly in consequence of the attitude taken by *Nature* and by Sir Lyon Playfair, who, it will be remembered, took Lord Armstrong sharply to task for his previous article on "The Vague Cry for Technical Education." It is a significant sign of the times that an article such as this on "The Cry for Useless Knowledge," from the pen of so eminent a mechanician, should be found in juxtaposition with the influential protest against competitive examinations and cramming, to which we alluded a fortnight ago. There must be something gravely at fault with our present systems of training when the methods of tuition and examination are thus called in question.

Sir Lyon Playfair having remarked that "the great revolutions of industry are generally produced by outside men of genius, who are not driving in the usual ruts of an industry, but who view its needs from without," Lord Armstrong retorts that there is much more danger of getting into academic than into industrial ruts, and that, in fact, there are no misleading ruts in the school of observation and experience. He asserts that had he acted upon the principle of choosing men for their knowledge rather than their ability, he should have been surrounded by an incomparably less efficient staff than that which now governs the Elswick works. He further says that it would be absurd to say that the successful competition of the company with foreign manufacturers is in any degree due to the educational measures it has taken; and as regards the advancement of the students themselves, "they are generally men of ability and good conduct, which favour their advance more than their superior education." Lord Armstrong exposes the fallacy of supposing that technical education will be of any value to bricklayers, tailors, or agricultural labourers, and puts the question whether we are to give instruction at the public expense to the 4,000 and odd trades and industries which are carried on in the metropolis alone; while, on the other hand, as he points out, a selection therefrom would be manifestly unfair. Why, again he asks, should ratepayers be burdened with the cost of providing English clerks conversant with foreign languages to merchants who are not satisfied with the cheaper services of foreigners? He, moreover, protests throughout vigorously against the curse of "cram," which he likens to putting out the fire with too much fuel. He states: "The German people are far from unanimous in favour of this educational pressure. I know for a fact that many competent judges in that country are regarding it with disapproval, and are dreading its effects." We hear of nothing but cram, and the "higher education," in the professor's language, "means more knowledge, although knowledge in itself is already a drug in the market."

Lord Armstrong repudiates "the imputation of hostility to knowledge, or to giving facilities for attaining it to those who desire to acquire it and have capacity to utilise it." But he deprecates the "plunging into doubtful and costly schemes of instruction, led on by the *ignis fatuus* that 'knowledge is power.' For where natural capacity is wasted in attaining knowledge, it would be truer to say that 'knowledge is weakness.'" This is really the cardinal point—the development of faculty, not the cramming with facts; and this indicates the direction in which educational reform should tend in the immediate future.

PROPOSED NEW TELEGRAPH CABLE TO AUSTRALIA.

An important meeting, convened by the Pacific Telegraph Company, Limited, of representatives of leading London houses, was held at the City Terminus Hotel, Cannon Street, London, on Thursday, the 22nd inst., to consider the laying of a new telegraph cable across the Pacific from Canada to Australia. The Earl of Winchester, who presided, said the question they had met to consider was whether the time had not arrived when the existing means of communication should be improved. He maintained that the present tariff of 9s. 8d. a word was, if not prohibitive, so high as to lead to very restricted intercourse. As to the important question of continuity, on three occasions during the last four months telegraphic communication between this country and Australia had been entirely interrupted. In a time of war the existing lines of communication would be, he believed he might say, absolutely defenceless. Passing through the Isthmus of Suez, they were, he said, liable to be cut at any moment. The proposed new cable would connect with existing and strong and dependable lines of communication between this country and Vancouver. With regard to the physical difficulties of laying a cable across the Pacific, the question had been referred to experts, and the consensus of their opinion was that it was a perfectly practicable route. There was already a cable to Pernambuco, which was only 200 miles less in length than the longest stretch of cable now proposed; and the experience in regard to the deep-sea cables already laid was that they were very much less liable than were cables laid in shallow seas to the attack of insects which destroyed cables, or to the effects of currents which caused attrition at the bottom of the sea. The bottom of the Pacific, as they knew from soundings, was, generally speaking, except where the cable could be easily protected, composed of a kind of soft mud, which was very favourable to the "life" of a cable. The water, too, was colder at great depths—a fact also in favour of deep-sea cables; while another great point in their favour was their great safety in a time of war. It would be extremely difficult, if not impossible, to destroy a cable at the depth at which they proposed to lay their projected line, and in that fact would lie a very great imperial safeguard. One great advantage in connection with the new cable would be the reduction of the tariff from 9s. 8d. to 4s. a word—a measure which would probably lead to a very great development of trade between the western shore of the Pacific and the Australian shore. The guarantee for which they asked was not in the nature of a subsidy, but was merely a guarantee that the governments would, in proportions to be arranged between themselves, guarantee to use the proposed cable to the extent of £75,000 a year. The governments therefore, he contended, would get a *quid pro quo* in the form of traffic in return for every shilling they spent on the line.

Sir Donald Smith said he regarded the enterprise as worthy of every support which could possibly be given to it by the commercial community of London. The sum mentioned as the guarantee required would, he thought, be very small to pay for so great an object, and he concluded by moving the following resolution, which was unanimously adopted:—

"That in view of the unsatisfactory state of the existing telegraphic communication between Great Britain and Australasia, this meeting most strongly approves of the proposal of the Pacific Telegraph Company, Limited, to lay a cable across the Pacific Ocean from Vancouver Island to Australia, touching at Hawaii, Fanning Island, Samoa, Fiji, and New Zealand, and to reduce the tariff from Great Britain to Australasia to 4s. per word; and that this meeting, believing that the laying of such a cable would be of great benefit to commerce in time of peace and a safeguard to imperial interests in time of war, trusts that Her Majesty's Government will do all in their power to facilitate the laying of such a cable, especially by obtaining the necessary soundings with as little delay as possible."

EMPLOYERS' LIABILITY AND RAILWAY ACCIDENTS.

On Monday last an important deputation of engine-drivers, guards, and other employés of the London and North-Western Railway Company, waited upon Mr. Matthews, at the Home Office, with a view to urge that the insurance clauses of the Employers' Liability Bill, which permitted the workman to contract himself out of its operations, should be retained, so that they might keep up the joint insurance fund of employer and employed, which they stated worked so well in connection with the various insurance societies of the London and North-Western Railway. About one hundred delegates attended, representing, it was stated, 50,000 members.

Mr. MacInnes, M.P., who introduced the deputation, said they were anxious that the insurance clauses should be passed as they left the Grand Committee. The deputation represented three different societies, which were in each case managed by the men themselves. The members contributed according to the wages they received and the position they occupied, and the railway company had for many years subscribed fivepence for every sixpence contributed by the men. The men were, therefore, extremely anxious that the insurance clauses in the bill now before Parliament should not be rejected, as they felt that such a rejection would inevitably result in the breaking up of their societies, and place them in a much less favourable position with their employers in the event of injury than they were at present. The deputation, while anxious that these clauses should remain, was, he said, equally desirous that no action on their part should prejudice the position of workmen less favourably situated than themselves.

Mr. Matthews, in replying to the deputation, said the singular spectacle had been presented of absolute unanimity in preferring the present system of certain payments in all those calamities which fell upon the workman and his family over the precarious and litigious system which must be the result of the absolute application of any employers' liability act. He was satisfied that if all employers behaved as the London and North-Western had done, and contributed their due and fair proportion to the amount contributed by the men, the result would certainly be more beneficial to the men than any system of enforced liability, and it was in order not to destroy arrangements such as had been mentioned to him by the deputation that he introduced into the bill the third clause, which was intended to enable those insurance societies still to exist. They had endeavoured to so frame the bill that it should not interfere with those societies, and he proposed to abide by the clause, and to use what influence he had in the House of Commons to carry it into effect.

THE BIRKBECK INSTITUTION.

The sixty-fifth anniversary and distribution of prizes and certificates took place at this celebrated institute the other evening in the theatre of the institution, Dream's Buildings, Chancery Lane, London, the Lord Mayor presiding. The institution, which was founded by the late Dr. Birkbeck in 1823, has called into existence a large number of institutions of a similar character in Great Britain and the colonies. Since its foundation about 90,000 persons have availed themselves of its advantages.

The report for the past year states that from the returns of the successful candidates at the matriculation examinations held during the present year it is found that the institution takes the second place—thus occupying a position superior to that of the vast majority of the colleges which send candidates to these examinations.

The institution is still carrying on an active work in technical education, as is evidenced by the announcement that Whitworth exhibitions have been gained by three of the students. In addition to the above, the students gained 59 prizes and 794 certificates at the examinations of the Science and Art Department, and the institution still maintains the foremost position at the Society of Arts' examinations, 146 candidates having been successful.

PROPOSED NEW DOCK FOR LONDON.

It is proposed to apply for a bill in the ensuing session of Parliament for incorporating a company with power to make and maintain new docks in the parish of West Ham, Essex, to be entitled "The Imperial Docks of London."

The projected works will consist of a dock about 706 yards long and 353 yards wide, with a branch dock about 650 yards long and 216 yards wide, and a ship lock and two barge locks, with entrances from the river Thames, to be situate partly on the site of the Victoria Graving Docks and partly on other property and lands specified, "such lands being bounded on the north side by the Victoria (London) Docks, and on the south by the river Thames." The bill will contain clauses empowering the company to construct, in connection with the proposed docks, a river wall or embankment and three piers or jetties on the bed and shore of the river, one at each side of the entrance to the said locks, and to make and maintain a railway connecting with the Great Eastern Railway at Silvertown. By other clauses authority will be sought for to raise the North Woolwich Road, to make a navigable cut through it, and to erect over it swing or telescopic bridges for road, railway, and foot traffic; to erect pumping engines, to divert water from the Thames, to dredge and deepen portions of the river, and to exercise all such powers as are usual in the case of dock companies. Powers will also be sought for to run over a portion of the Great Eastern Railway, and to enable the company to pay interest during the construction of the works.

BOILER EXPLOSIONS.

Recent Board of Trade Reports.

Since our last reference to these reports a number of others have been issued. The following is a continuation of the series from the point reached in our last notice.

Fracture of Uptake of a Vertical Boiler.

Report No. 281 refers to the failure of the uptake of a vertical boiler on board a fishing smack, about 50 miles off Lowestoft, on the 2nd of April last. The boiler was of the type usually employed for working the trawling gear on board these vessels, and the failure arose from a slight collapse of the uptake in the steam space, a little above the water level. The position and extent of the fracture will be readily understood by reference to the accompanying illustration.

When seen by the Board of Trade surveyor, the hole had been somewhat enlarged by a workman, and then measured 5in. long by about 2½in. wide. The uptake at the part where the collapse occurred is stated in the report to have been "no thicker than brown paper," and was thus unable to resist the ordinary working pressure.

Although it had no direct bearing upon the cause of the explosion, it may be mentioned that the safety valve with which the boiler was fitted was loaded with a spring balance in such a manner that it could be rendered quite inoperative by simply turning the thumb-nut, so that the pointer could be jammed hard and fast against the bottom of the slot, as shown in the accompanying illustration, which is taken from the Board of Trade report. When in this condition, the case of the balance, it will be seen, is drawn out to the fullest extent, and it becomes converted into a rigid tie-rod between the point of attachment and the end of the lever. To avoid such a possibility it is important that safety valves loaded with spring balances should either be fitted with a ferrule so as to prevent the overscrewing of the thumb-nut, or else the point of attachment at the bottom of the spring case should be raised so that the lever may come to a bearing against the upper case before the pointer reaches the bottom of the slot, and thus leave a little play in the spring. From the illustration it will be seen that the fitting was of a very rough character, which we are sorry to say is too often the case with these small boilers. They are frequently placed in the hands of men who have no special knowledge of steam machinery, and who appear to imagine that there is not the slightest risk in working a boiler so long as it is well supplied with water, whatever its condition may be in other respects. As a matter of fact these small vertical boilers give rise to almost as many Board of Trade reports as all the other types put together, as will be seen on a reference to these records.

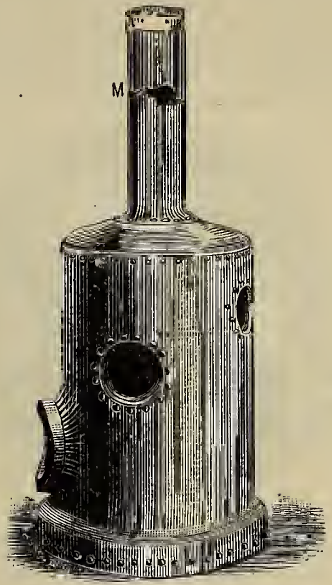


Fig. 1.

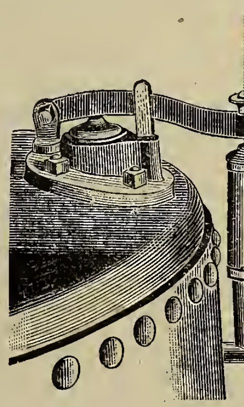


Fig. 2.

The deterioration of the uptake in the steam space above the water level is a defect to which they are specially liable, and several casualties referred to in these reports deal with similar instances of failure. The defect is largely due to the rapid oxidation consequent on overheating, especially when the uptake is not protected from the action of the fire. To accomplish this it is desirable to furnish the uptake either with an internal lining of fire-clay or a loose sleeve of cast iron, dropped in from the top, so as to leave a small annular air space between the two. The uptake, however, is often so small in diameter as to prevent either of these plans being adopted, and in such cases it is well to provide against corrosion by making the uptake of thicker plate, to allow for wasting.

Collapse of the Fire-box of a Vertical Boiler.

Report No. 282 deals with an explosion which occurred on board a steam launch on the Clyde, between Glasgow and Greenock, on the 26th of June. In this case, again, the boiler was of the ordinary vertical type, fitted with vertical uptake and two cross water pipes. It measured about 4ft. in diameter by 7ft. high in the shell, and 3ft. 8in. in the fire-box, which had a diameter of 3ft. 5in. The shell was composed of four plates originally ⅜in. thick, placed vertically and joined with single-riveted lap seams. The firebox consisted of two plates, joined with vertical single-riveted seams similar to those in the shell. The plates, which were of iron, appear to have been originally $\frac{5}{16}$in. thick, but were reduced by corrosion to ¼in. The rupture appears to have occurred in the first instance at the root of the flange uniting the uptake to the crown of the firebox, and upon the severance of this stay the firebox was collapsed, and forced downwards through the mouth of the shell at the bottom. The contortion and bending of the plates effected by the process will be better realised by reference to the accompanying illustration. As will be seen from this, several ruptures were made, and the re-action of the water and steam which issued from them projected the boiler upwards through the deck of the vessel and into the river. The deck beams, knees, rails, and stanchions were torn up on each side amidships, but fortunately no person was hurt.

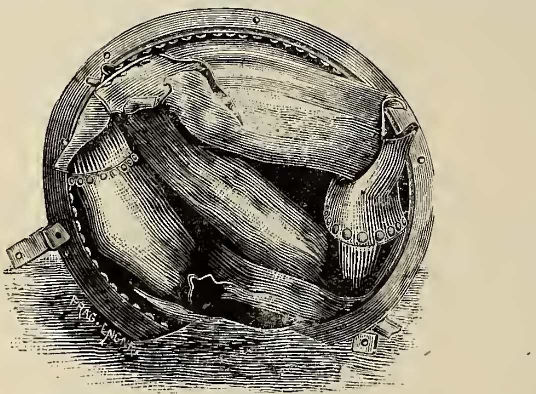


Fig. 3.

The Board of Trade surveyor states that from the appearance and distortion of the firebox plates, he was of opinion that the explosion was caused by the "over-heating," in consequence of "shortness" of water. Whether the shortness of water occurred from neglect or inadvertence is not very clear.

A Spot of Corrosion.

Report No. 283, like many others of the casualties with which these documents deal, can hardly by any stretch of the word be characterised as an explosion. The casualty to which the report refers occurred on the steamship Doom, belonging to the Ayr Steam Shipping Co., whilst off Ailsa-Craig, and arose in consequence of a pitting of corrosion at the bottom of the starboard furnace eating its way through the plate, with the result that steam had to be let down and the vessel put under sail.

We have no desire to minimise the importance of steamship machinery being maintained as efficient as possible, or to underestimate the serious results which may follow from a slight disorganisation of the motive apparatus on board ships, but we have known of cases where the fracture of a gauge glass has constituted quite as serious a difficulty as the one in question, which has been thought worthy of an official report. It would be just as reasonable that we should have an official investigation of the failure of a crank, the fracture of a pedestal bolt, the breakage of a water-gauge glass, or the one hundred and one little breakdowns that are matters of daily occurrence on board steamers, as that such casualties as the one in question should be investigated in this way.

Our criticisms are not made in a carping spirit; we simply desire to show how trivial are many of the casualties which are dealt with in these preliminary inquiries.

Fracture of a Cast-iron Steam Pipe.

Report No. 283*a* refers to the fracture of a cast-iron steam pipe on board a steam trawler, off Whitby, on April 5th. The pipe, which was 6in. in diameter by ⅝in. thick, fractured at the root of the bend, in consequence of insufficient allowance being made for expansion, and thus allowed the steam to escape.

Failure of a Sight-hole Cover.

Report No. 284 refers to the blowing off of the cover of a sight hole at the bottom of the firebox of a tramway engine boiler, at Bradford, on July 20th. The failure was due to the fracture of the T-headed bolt, at the junction of the threaded part with the shank which secured the door. The joint of the sight hole appears to have been leaking, and from the evidence elicited at the inquiry, it appears very probable that the driver, who was somewhat severely scalded, was in the act of tightening up the door at the time it gave way. It is no doubt better for the doors of such sight holes to be placed inside rather than outside the boiler, so that their safety may not depend entirely upon the bolt. We should hardly be prepared, however, to endorse the statement of the Board of Trade surveyor, viz., that the doors of all manholes or mudholes in steam boilers should be placed inside. Such a remark smells rather too strongly of marine practice; and though no doubt it sometimes may be very convenient on board ship, on account of space, to have manhole covers inside, yet they are far more convenient to get at when placed outside, and preferable if space will admit of their adoption.

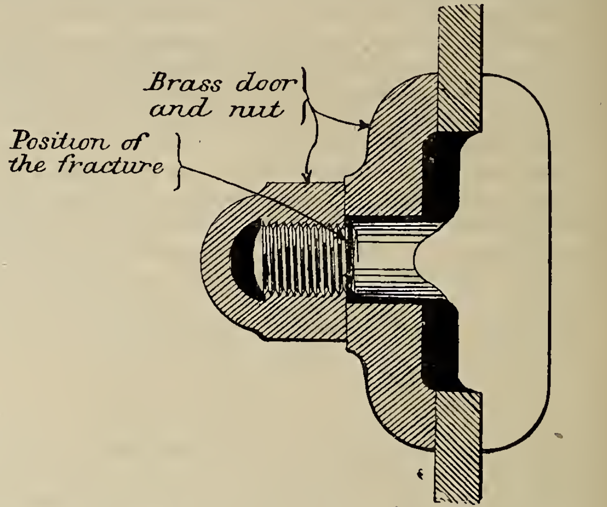


Fig. 4.

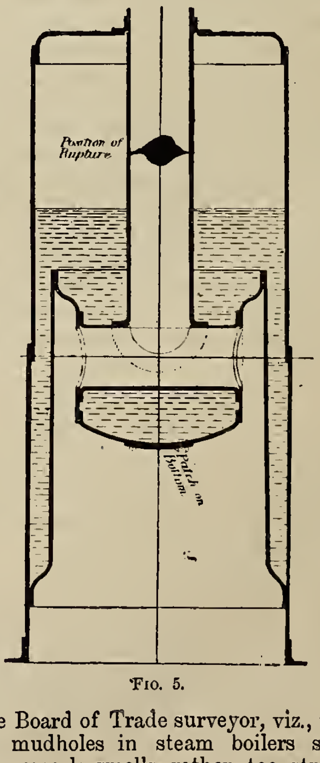


Fig. 5.

As such covers do not depend for their safety upon a single bolt, the strictures made with regard to the small cover referred to do not apply.

Failure of Uptake of a Vertical Boiler.

Report No. 285 deals with a case very similar to that referred to in report No. 281, and, like that, took place on board a fishing smack in the North Sea.

The failure occurred on July 25th. The position of the rupture was very similar to that already described, viz., in the steam space a little above the water level. As will be seen from the sketch shown in fig. 5, the boiler was of somewhat peculiar construction, though the type had nothing specially to do with the position of the rupture. As in the previous case, the uptake was not protected with any internal lining either of firebrick or cast iron, and the plate appears to have been wasted away locally at the part where it gave way till it was only about $\frac{1}{16}$in. in thickness. The opening formed by the collapse measured about 5in. long by 3in. wide. Through this the contents of the boiler escaped, and rushing into the cabin through the furnace door, so severely scalded four of the hands who were below at the time that two of them subsequently died of their injuries.

(To be continued.)

MANCHESTER SHIP CANAL.

This important undertaking, which was instituted with the object of placing Manchester in direct communication with the sea, so as to permit of the largest ocean-going steamers being brought to the doors of its warehouses, has now been in process of construction for about twelve months, so that the present is a convenient opportunity for noticing the work that has been accomplished.

It was on the 11th of November, last year, that the first sod in connection with the work was cut at Eastham, near Liverpool. The ceremony was of an exceedingly simple and modest character, while it was at the same time eminently typical of the matter-of-fact and business-like character for which Manchester men have made themselves famous. There was no silver trowel, no procession, no music, no speech-making. An ordinary workman's spade, which had seen some good service, was handed to Lord Egerton, the chairman of the directors, by Mr. Walker, the contractor, and with this honest implement he proceeded, without more ado, to cut the first sod of the Manchester Ship Canal from its mother earth. The spade was then passed round to the other directors, who, each in their turn, performed a similar operation. The barrow into which the sods had been thrown was then tipped by Mr. Leader Williams, the engineer to the scheme, and the workmanlike ceremony was then at an end. The motto for the proceedings appeared to be "By their deeds shall ye know them." In this wise was the gigantic undertaking, which was so ably championed by Mr. Daniel Adamson in its early and critical stages, and with which his name will be indelibly associated, first begun. The only touch of sentiment relieving the bareness—we might almost say rudeness—of the proceedings consists in the fact that the spade which was used has found an honoured and final resting-place in the home of the chairman at Tatton Hall, where, we doubt not, it will long remain, treasured as a heirloom, perhaps all the more precious because of the utter absence of the artistic embellishments with which the implements used on such august occasions are generally decorated.

Mr. Walker, the contractor for the canal, was not long in buckling to his work. For some time he had been getting materials together, and within a week of the inauguration ceremony he had two thousand men on the ground. As the operations opened out the forces were gradually increased, and at present the number of men is over 10,000. The men, however, represent but a small portion of the force brought to bear in this great digging enterprise.

The bulk of the excavation is being done by the steam digger, and of these cyclopean tools 85 have been pressed into service. Three of them are of German make, two come from France, and the rest are of English construction.

In addition to these, 100 locomotives and 5,000 wagons are constantly at work, and the lines of rails put down for temporary purposes cover about 200 miles. So much effective strength has never before been brought to bear upon a contract of this kind, and as a matter of course the amount of work done has been enormous. The whole course of the canal is now in outline, and in some places the excavation is in a rough way complete. The progress made during the year is, we believe, regarded as eminently satisfactory, and there is every reason to believe the work will be finished to time. Mr. Walker has a name for getting done within the limit of his contract, and in the present undertaking his reputation is, we believe, involved as it never was before.

It was on the site of the entrance locks that the directors cut the first sods. The particular spot has long since disappeared, and the whole look of the place has changed. The excavation in the great lock has been carried down to the invert level, a depth of about fifty feet. Further excavation will be found necessary for foundation purposes, but the work is so far forward that the construction of the lock gates is in progress. It is difficult to give readers an idea of the great red gulf the steam digger has made here. The width of it is about 400ft., and the average depth 35ft. or 40ft. Its width of 400ft. it keeps for a distance of about 600ft.—the length of the largest of the three locks—and then tapers off into the ordinary width of the canal. Vessels of small tonnage could of course enter by the great lock, but it would be at an unnecessary expense of water. The great red gulf we speak of is a scene of enormous activity, and amidst the confusion of locomotives and steam diggers it is not easy to grasp the details. At the lowest level the new red sandstone has been reached, and the final excavation will have to be done by blasting. But as a great deal of stone will be needed here for building purposes, it is no doubt convenient to have it at hand. Most of the marl and stone now coming out of this vast quarry goes towards Pool Hall, where the canal has to be taken across a deep bight in the coast line. Some progress has been made with this work, but the embankment is not yet above high-water level. The number of men on the Eastham section is about 1,000, and for their accommodation a village of wooden houses has sprung up under the shelter of the hill.

Between Ellesmere Port and Holpool Gutter the excavation has in various places been taken out to the full depth of the canal. Between Holpool Gutter and Weston Point the German steam digger has done good work, and is to have the assistance presently of one on the French system. The sluices at the river Weaver are to be started soon, and at the lock at Weston Marsh the work is so far forward that the concreting of the walls is now going on.

On the Runcorn section progress is most noticeable at No Man's Land. Between Randles' Sluices and Latchford a great deal of blasting has been done, the rock coming nearer the surface here than at some other points. The diversion of the Mersey at Latchford Locks has been finished, and a start has been made with the railway deviation, which begins at a point near Warrington and ends at Thelwall Station. Section No. 7 was the last section to begin work, but in the four months much has been done, especially in the excavation of the Irlam locks, and the work connected with the deviation of the Cheshire Lines Railway which will be necessary at this point.

The docks at Salford are in a forward state. They are intended to consist of three branches opening out of the canal, which at this point is much wider than usual. The excavation of the mid branch is nearly complete, and on one side the concreting of the wall is in progress. The other branches are not so far advanced. The river, it is expected, will give some trouble at this point, and extensive works are in progress to take it out of the way for a time. The material dug out at Salford is mainly gravel, with clay and rock at the bottom. The gravel and rock will be used in making the concrete walls. The rest of the spoil is in part deposited on land near the Manchester Racecourse, and in part sent down towards a place called Stickins Island, where the diversion of the river is now complete.

A New Boiler Works.—The manufacture of steam boilers has made great progress during the past few years, and it is imperative, on the part of those who wish to maintain a front rank, that their work and plant should be in keeping with present requirements. Messrs. Tinker Brothers, of the Daisy Field Boiler Works, Hyde, appear to be fully alive to this fact, and deserve credit for the enterprise displayed in the extensive new works they have recently erected. The works, which are now completed, are equipped in the most thorough manner with the best modern tools and appliances. The works have been designed with great care, and are a decided acquisition to the neighbourhood. The main boiler-erecting shop, which measures 200ft. in length by 60ft. in breadth, is fitted with a powerful travelling crane capable of lifting boilers up to 40 tons weight. The plate-edge planing machine is a splendid tool, and will plane a plate 30ft. long, both on sides and ends at the same time, thus enabling the firm to construct the shell rings of even the largest boilers in one plate. The shell-drilling machines, flanging machine, turning machines, riveting machine, &c., are all equally first-class tools, suitable for producing the highest quality of "steel" boilers, in the construction of which Messrs. Tinker have had great experience.

DIAMETERS OF STEAM AND EXHAUST PIPES.

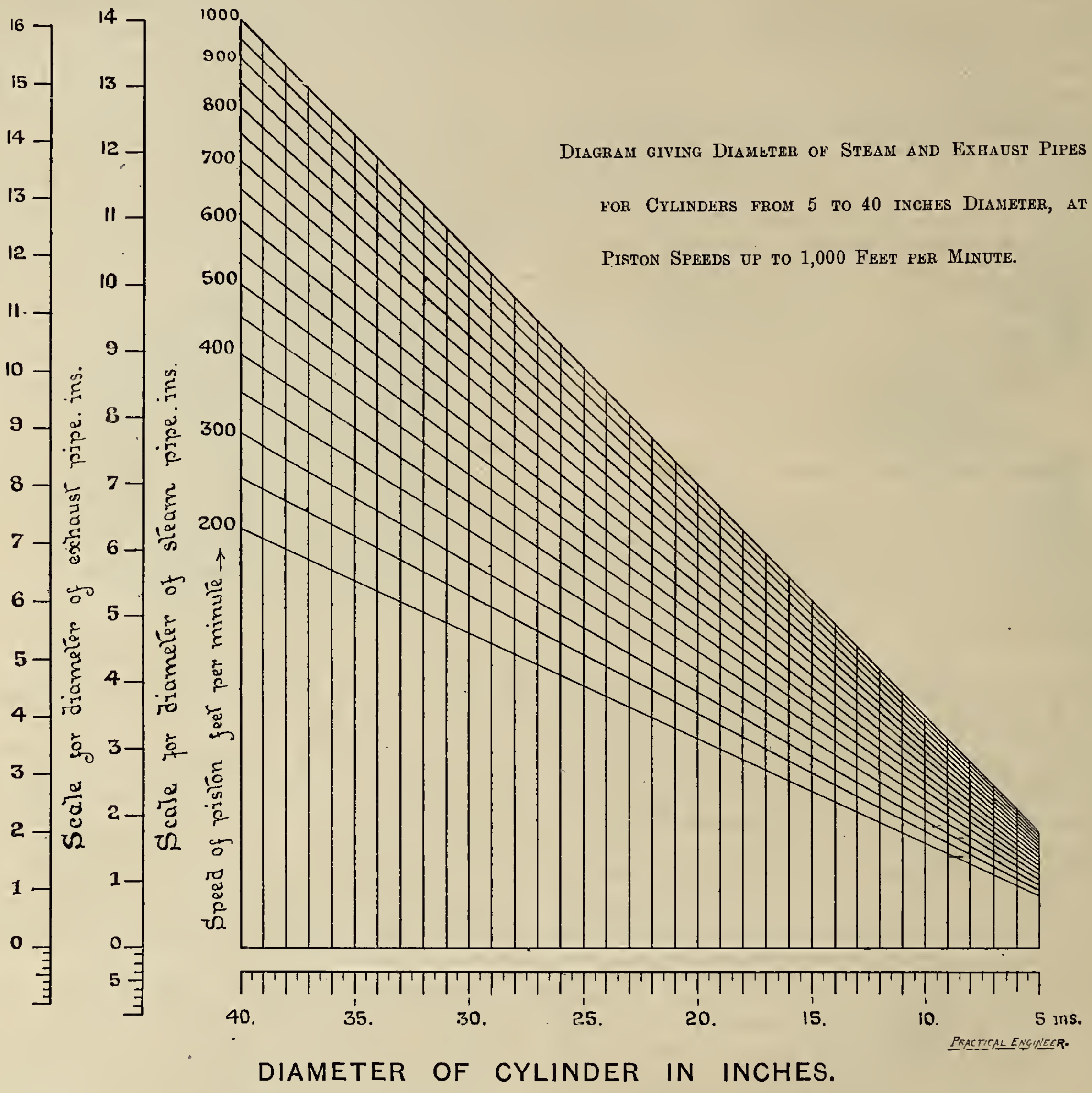


Diagram giving Diameter of Steam and Exhaust Pipes for Cylinders from 5 to 40 inches Diameter, at Piston Speeds up to 1,000 Feet per Minute.

That the loss of pressure between the boiler and the valve chest may not be excessive, the main steam pipe which supplies the cylinder with steam should be of such a size that the mean velocity of flow through it does not exceed 8,000ft. per minute, so that its cross sectional area must bear the same ratio to the area of the piston as the speed of the piston does to 8,000; or if

A = area of piston,
S = speed of piston in feet per minute,
a = area of the steam pipe,

then $a : A :: S : 8,000$; and since the areas of circles vary directly as the squares of their diameters, therefore, calling the diameter of the cylinder D and the diameter of the steam pipe d, we may write

$$d^2 : D^2 :: S : 8,000$$

so that $d = \sqrt{\dfrac{D^2 \times S}{8,000}}$

Further, if d_1 be the diameter of the exhaust pipe, and the mean speed be taken at 6,000ft. per minute, then

$$d_1 = \sqrt{\frac{D^2 \times S}{6,000}}$$

From these two formulæ the above diagram has been constructed, giving the diameter of the main steam pipe and exhaust pipe of cylinders from 5in. diameter upwards, and running at piston speeds up to 1,000ft. per minute.

As an example, suppose it be required to know the diameter of the main steam pipe of a cylinder 20in. diameter and 24in. stroke, the engine running at 125 revolutions per minute,

$$S = 2 \times 2 \times 125 = 500\text{ft. per minute.}$$

Then, at the point marked 20in. on the scale of diameters of cylinders at the bottom of the diagram, measure the length of the ordinate from the base line up to the line marked 500 on the scale of speed of piston, and transferring this to the scale of diameter of steam pipe and scale of diameter of exhaust pipe, read off 5in. and $5\frac{3}{4}$in. respectively, or by the formula,

$$\text{Diameter of steam pipe} = \sqrt{\frac{20^2 \times 500}{8,000}} = 5\text{in.}$$

$$\text{and diameter of exhaust} = \sqrt{\frac{20^2 \times 500}{6,000}} = 5{\cdot}78, \text{ or } 5\tfrac{3}{4}\text{in. full.}$$

Also this diagram may be used to find the area of section of the steam ports; and since in most engines the steam exhausts through the same ports and passages by which it was admitted, their size should be such that the velocity of flow of the exhaust steam through them does not exceed that given above for exhaust pipes; so that the sectional area of the steam ports = the area of the exhaust pipe, or (diameter of exhaust pipe)$^2 \times {\cdot}7,854$, which in the example given $= 33{\cdot}3 \times {\cdot}7,854 = 26{\cdot}15$ square inches; and making the length of the port = ·8 of the diameter of the cylinder, which is a common proportion, we have—

$$\text{Length of steam port} = 20 \times 0{\cdot}8 = 16\text{in.}$$

$$\text{and width of steam port} = \frac{26{\cdot}15}{16} = 1\tfrac{5}{8}\text{in.}$$

The area of opening of port to steam when at its greatest should be such that the mean velocity of flow does not exceed 10,000ft. per minute.

MANCHESTER ASSOCIATION OF ENGINEERS.

At a meeting of the above association, held in Manchester on Saturday last (Mr. S. Dixon in the chair), an interesting paper, illustrated with sketches and diagrams, was read by Mr. James Bolas, of Patricroft, entitled, "Some Types of Modern Locomotives."

Referring to the speed of our modern express trains, which has steadily been increasing during the last few years, Mr. Bolas said this was mainly the result of the rivalry existing between the various railway companies, and which reached its climax during the present summer, in what had been appropriately named "the race to the north." The interest which has been excited throughout the country by this race, added to the intrinsic merits of the engines themselves, claimed priority for this class. Locomotives were now running intended to attain very high speeds with heavy trains, and those who had watched the development of the locomotive in size and power knew there was a growing desire for still higher speeds.

It was, he said, the opinion of many that our railway companies could, if they liked, easily increase the speed of their fast trains, but, as a matter of fact, this was not so. The engines as a rule were now doing as much as they possibly could, and were so nicely and delicately timed that the slightest error of judgment on the part of the driver resulted in the train being late.

After speaking of the various classes of locomotives on the different railway systems, and of the improvement in their construction of late years, Mr. Bolas said that the latest departure in locomotive practice had been the introduction of compounding. This, strange to say, had in most instances been applied to the express locomotive, which, even when constructed in the ordinary manner, always worked with a high degree of expansion, owing to the difficulty experienced in getting the exhaust steam away at the great piston speed usually maintained. To his mind, the goods locomotive offered the better field for improvement by the use of expansive working, as these engines, with a much lower piston speed, and with the great loads they were required to haul, were mostly cutting off at from half to three-fourths the stroke. Latterly, he saw that Mr. Worsdell had compounded his goods engines, which was a step in the right direction.

All the experiments that had been made showed there was a gain in the efficiency of the locomotive by compounding over other locomotives that had been doing the same work, but whether there was any gain in the end over the best possible design of the ordinary locomotive for that work, when they took into consideration the increased first cost and the extra expense for maintenance, was, he thought, open to doubt. Still the compound locomotive was yet in its infancy, and its possibilities were great.

A strange fact in connection with compounding was that locomotives having cylinders without steam jackets had proved more economical than those on which they had been provided. This, he was of opinion, was caused through the inefficient manner in which steam jackets were usually drained, causing them to act as condensers, many engineers thinking that if they only surrounded their cylinders with high-pressure steam they had done all that was needful. This, however, without automatic draining apparatus, often proved a source of loss instead of gain.

In Mr. Worsdell's latest compound passenger locomotive, the most powerful of their class in the world, which in the race to the north had no doubt been doing their utmost, the fact remained that we had not a locomotive that could, or at least did, make a trip of say 100 miles on our average roads, timed to travel at the rate of 60 miles in 60 minutes. Given a perfectly straight and level track, in good order, the question which at once presented itself was what was the maximum speed at which a locomotive and train might run with safety. It being assumed that sufficient power was available, and the road was strong enough to bear the weight required for adhesion, he believed that with a properly designed locomotive the limit of speed was far beyond anything yet attained.

Explosion on Board a Glasgow Steamer.—As the Clyde Shipping Company's steamer Inistrahull was proceeding down the Shannon on Saturday last, on her voyage from Limerick to Glasgow, the tube of one of her boilers burst, and the engineer and stokers were badly scalded. The engineer was so severely injured that he had to be taken back to Limerick Hospital. The mishap to the machinery having been made good, the Inistrahull resumed her voyage.

RECENT ADVANCES IN ELECTRICITY.

The technical journals devoted to electricity have recently recorded quite a number of enterprises illustrating the extensive progress which is being made in the application of electricity to industrial and illuminating purposes.

At Bradford the corporation has taken the lead in establishing an electric lighting station to supply residents in the central portion of the town, the current to be charged by meter. At Halifax a new mill engaged in spinning coloured yarns has been furnished with sixty arc lamps, each of 2,000 candle power, and with 500 incandescent lamps, with the result that the operatives are able to effectually manipulate the numerous shades of colour all the time the machinery is running.

At Deptford a large central station is being erected to furnish current for 250,000 lamps, ultimately to be extended to 2,000,000. In Birmingham a block of business premises has been supplied with 1,000 16-candle incandescent lamps and two 3,000-candle power arc lamps. Further installations are also in progress at Leamington, Liverpool, Dublin, Chelsea, and Newcastle; also at the Savoy Mansions, the library of the Royal College of Surgeons, and at the house of the Earl of Rosebery, at Mentmore.

On the continent the new illuminant is making considerable progress, especially in Italy, on account of the high price of gas and the abundance of water power. At Tivoli the public thoroughfares are well lighted, each public lamp being fed by a secondary generator. At Milan the main streets are lighted from a central station, places not easily workable from the centre having transformers. Throughout the country the principal railway stations, factories, and theatres are electrically lighted, as is also the Cathedral at Milan.

At the Cincinnati Exhibition decorative electric lighting is a specialty, some of the features being a cascade studded with moving coloured lights, "which twinkle, oscillate, change colour, and disappear, producing charming effects;" a rainbow of lamps; a fountain filled with submerged light, another surmounted with a dome of lamps flashing in time with the music; huge fish-shaped Japanese lanterns, the lamps in the interior provided with revolving switches to give the illusion of swimming; a rotating tropical garden; and a monstre Edison lamp, composed of 15,000 perfect lamps.

In telegraphy further progress is being made with the plan of signalling without wires. By a combination of the telephone with the Morse telegraph good results have recently been obtained at sea, although the weather was tempestuous. Long-distance telephony is also progressing; and the hope may be entertained that the North of England may soon be in speaking connection with the South.

Electric traction, it is thought, will receive an impulse from the invention of the Commelin-Desmazures arrangement, which is described by the electric adviser to the French Government, and other competent authorities, as superior to anything of the kind hitherto produced.

A New Gas.—What is said to be a new and useful gas for lighting and heating purposes has been invented by Mr. F. J. Lothammer, of 6, Lombard Court, London. It consists of an intimate admixture of air and hydro-carbons, and is produced in a special apparatus. The generator, which is portable, consists of a metallic cylinder, within which is a smaller one, having a chamber formed around its interior. Air, under a pressure of about 10lb. per square inch, is delivered into the space between the outer and the inner cylinder, whence it is conducted to the mixing chamber, which is the central portion of the inner cylinder. To this central portion is also conducted a supply of gasoline, which is stored in the chamber surrounding the interior of the inner cylinder. The compressed air is made to pass upwards through the gasoline, with which it combines, forming the gas which is led away to the burners direct, or for any other use. A small gas engine or other power is required to compress the air, and the gas is produced directly the engine is started. The gas is not stored, but is made as required for use. It is stated that one gallon of gasoline, costing 1s. 6d., will produce 800 cubic feet of gas of high illuminating power. The gas gives a clear white light, and appears to be free from condensation in the pipes. It is proposed to place generators in private dwellings, public buildings, or other establishments, and to have central stations for compressing the air and delivering it to users, who will thus make the gas on their own premises. In this case, by simply turning on a tap the process of manufacture will be commenced, and by turning it off the production will be stopped.

Large Order for Rails.—The Pennsylvania Railroad Company has contracted with various Pennsylvania mills for the supply of 45,000 tons of steel rails, to be delivered next year at $28 per ton. This contract, which shows an advance on recent prices, has strengthened the iron markets.

HELICAL WHEELS.—I.

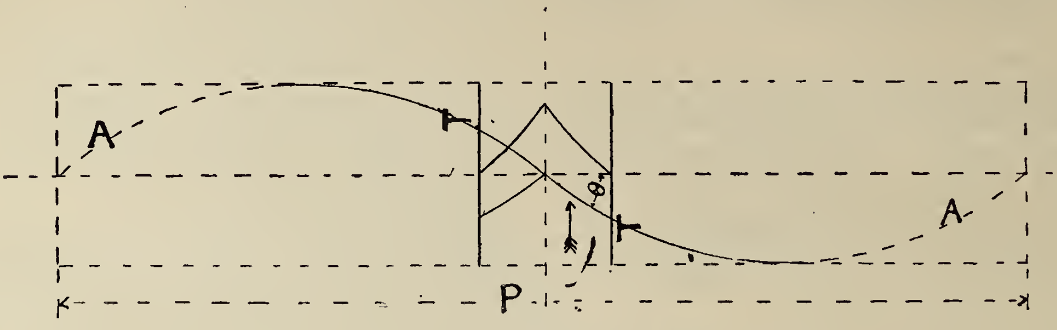


Fig. 1.

If we observe the mode of action of the teeth of a pair of ordinary wheels, we see that it must, of necessity, be of an irregular character. Contact occurs mainly by rubbing and sliding—very slightly by rolling—the former predominating during the periods of approach and recess, the latter at and near the "pitch point," that is, the point where the line of centres of the wheels cuts the path of contact of the teeth. This irregular action, and consequent friction and variation in stress, is an evil inseparable from ordinary toothed gearing, and is the principal cause of the noise which results when wheels are driven at high speeds. To reduce the pitch will minimise the evil, but will also weaken the gears, and is therefore inadmissible. The adoption of the helical or screw form causes the teeth to be in contact always precisely at the pitch point, so that there is no sliding, but absolute rolling. Both in theory and practice, therefore, these are the perfection of toothed gearing.

The original germ of the helical wheels is to be found in Dr. Hooke's stepped gears, which were long ago employed for planing machines and other special forms of mechanism. The principle of these is, that if a wheel is supposed to be cut in a direction perpendicular to the axis into a series of slices, and these slices are placed at uniform distances in advance of each other around the circumference, the mutual action of a pair of such gears is that of a succession of contacts upon, and very close to, the pitch point. In proportion to the number of such slices does the action of the wheels approach that of simple contact by rolling friction, instead of by sliding mainly, as is the case with common gears. From such stepped gears the transition to a helical or screw form is obvious. By obliterating the angles, and blending the steps into one continuous curve, the screw is obtained, and the number of contacts becomes infinite. No contact at all then takes place away from the pitch point, and the approximation of the stepped gear is improved upon in the perfect action of the screw gear.

The connection between the helical toothed wheels and the true screw is seen in fig. 1. There is a helix, A,A, of axial pitch, P, and the tooth centres coincide with a series of such helices arranged around the pitch cylinder. The angle, θ, of the tooth centres, T,T, coincides with the angle which the helix makes with the plane of the axis of the cylinder around which it is wound. Each tooth is therefore a very short section of a helix of very long axial pitch.

Almost invariably these wheels are made *double* helical. Then the teeth are sections of right and left handed helices, corresponding with each other in axial pitch and angle. Being double, the diagonal thrust on the shaft produced by the teeth upon one side of the middle plane is exactly balanced by the thrust of the teeth on the side opposite.

It is also obvious that the principle of stepped gears, and therefore of helical gears, can be applied to bevel as well as to spur wheels. In stepped bevel wheels the distance apart of the successive steps will properly diminish towards the apex of the cone, just as the tooth sections themselves diminish; hence a continuous curve drawn through such steps will develop a helical form of tooth.

The development of a spiral curve upon a cone is not difficult by the method of intersections. If (fig. 2) we equally divide the height, A, of a primitive pitch cone, and also its diameter, B, and draw radial lines as convenient, and delineate a curve, C, through successive intersections, this curve will then be a true helix developed on the pitch cone, just as though we had revolved the cone in a lathe, and traversed a marker thereon, parallel with its axis, at a definite and equable speed. This will coincide with the pitch line passing through the teeth from one face to the other. The height of the cone, considered in relation to its diameter, will differ with the bevels of the primitive pitch cones, in different wheels, and the angle which the helix makes with the central

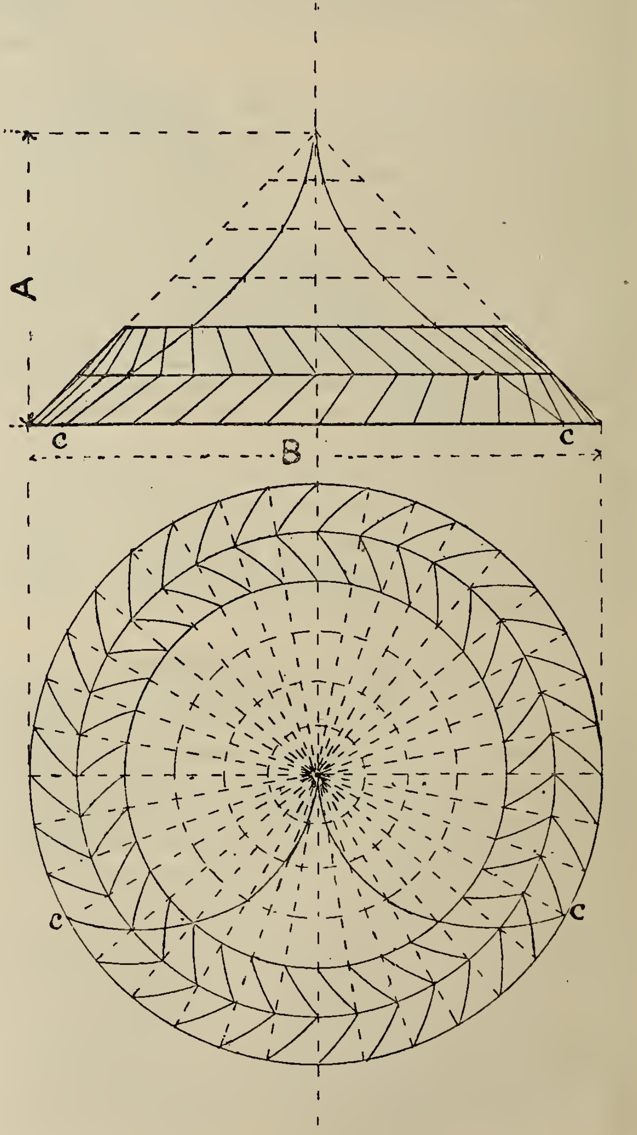


Fig. 2.

axis of the cone will vary with breadth of tooth, precisely as in spur gears. But this is the important point to be borne in mind, that in both spur and bevel wheels the form of the true screw be strictly adhered to. Also, in bevel wheels, the right and left handed helical curves must meet, if prolonged, at the apex of the pitch cone. Short sections of these curves, so obtained, give the centre or axial lines of the double helical teeth. This is clearly seen in fig. 2.

We may regard the spur wheels as a modification of the common twist or spiral gears, in which the threads of a pair of wheels, when of the same hand, cause the axes to become crossed. In helical gears they are of opposite hands, right and left, and then the axes become parallel.

Now, it is obvious that the determination of the axial pitch, P (fig. 1), of a helical gear will not avail as it does in the case of a worm, and is therefore of no practical value; so we discard that at once, and do not attempt to strike out the wheels by the methods of screw projection. Within wide limits the angle of the screw threads is arbitrary. The only conditions regulating this are as follows: It is desirable that one pair of teeth shall not quit contact until contact commences at the next pair; hence the tooth angle should at least be such that this condition shall be fulfilled, as in figs. 1 and 2. Neither is it desirable to exceed this much, because increase in angle is a source of weakness when the pressure is taking place in the direction of the arrow (fig. 1); therefore the angle should not be materially different from that shown in figs. 1 and 2, and this will evidently depend entirely upon the *pitch* and *width* of wheel. J. H.

NEWCASTLE FOREMEN ENGINEERS' AND DRAUGHTSMEN'S SOCIETY.

The seventeenth annual dinner of this association was held on Saturday last, at Newcastle-on-Tyne, Mr. J. W. Spencer in the chair. Amongst the guests were the Mayor and Sheriff of the city, as well as Sir B. C. Browne and Professor Garnett, of the Newcastle College of Science.

The Mayor, in the course of his remarks, said that a period of substantial industrial improvement was at hand, and that the rate of freights from the Black Sea and Russian ports was, he believed, higher now than it had been for five-and-twenty years.

The Secretary of the Association, in presenting the annual report, said that although the expenditure had been heavy, they had a balance to add to their funds, which now stood at £942.

The Chairman, in proposing the toast of the association, denied that the managers, draughtsmen, and foremen in this country were in any way inferior to those on the Continent, or that the depression in trade from which we had recently suffered was in any way due to their deficiency in what was called technical education. On the Continent they had no doubt first-class schools where people obtained a theoretical knowledge of the sciences. He thought, however, it was far better for the education to begin, as it did in this country, at the other end, by a thorough training in the workshops; and in the matter of skill and intelligence which was brought to bear upon their work, he maintained that the English workman was far ahead of his continental rival. It was all very well to have laboratories for physics and chemistry, but they did not want workshops where men merely obtained a baby-house instruction in engineering. He had had some experience of men from technical colleges, but it was not a very flattering one. He did not despise the advantages of education, but in the training of an engineer the theoretical and the practical training should, he thought, go hand-in-hand.

Sir B. C. Browne, in responding to the engineering industries of the district, said that it was rather curious that of the number of machine tools used on the Tyneside, only a few were made in the district. He did not see why they should not make these on the Tyneside just as well as they built steamers.

Professor Garnett, principal of the Newcastle College of Science, said he had always been against the introduction of tools into public elementary schools. He did not believe in a college attempting to teach the practical side of a trade, and in the scheme which had been drawn up for the Newcastle College of Science this was avoided. As an educational institution they ought not to have upon their shoulders the responsibility of teaching trades, and if they attempted to do so they would be beaten in competition by the works. Still, he thought they would agree with him that a little technical education was required, even amongst the ordinary population of the town. They needed one or two things at the college. What they wanted most was a professor of engineering, a skilled man, with a first-class theoretical education; and they wanted also a teacher of metallurgy.

SEALE'S WATER PURIFIER.

The question of the purification of water, and the prevention of scale in steam boilers, is not only of considerable interest, but also one frequently entailing considerable expense, as many steam users know to their cost. Numerous attempts have been made at various times to grapple with the difficulty, but in only a few instances can such success as has been attained be regarded even as qualified. In the great majority of cases the remedies that have been put before the steam user as a panacea for their troubles in this direction have proved, on trial, to be lamentable failures.

In order the better to realise the difficulties of the problem, and the manner in which they are overcome by the apparatus named in the heading of this article, it may be of convenience if we consider briefly the nature of the impurities generally found in the feed-waters of steam boilers. We have the less diffidence in doing this as we find many steam users entertain rather hazy ideas regarding the formation of scale in steam boilers, and the means best calculated to effect its removal.

In the majority of cases the objection to the water, if any, generally arises from the fact that it is impregnated with the salts of lime and magnesia, in the form of carbonates or sulphates, and the extent to which these salts are present varies with the different localities and sources from which the supply is drawn. Their presence, of course, is not visible to the eye, but their peculiar action upon soap renders it easily discernible, and gives rise to the popular distinction of "hard" and "soft" water, according as the salts are present in greater or lesser quantity. This hardness of the water, as every housewife knows, may generally be remedied to some extent by boiling, which leads us at once to discriminate between hardness as "temporary" or "permanent," according as it may or may not be removed in this way.

"Temporary hardness" is due to the presence in the water of the *carbonates* of lime or magnesia. These salts are readily dissolved in water which contains carbonic acid, and when this acid is driven off by boiling they are slowly deposited on the surfaces of the vessel, constituting what is known as fur in tea kettles and scale in steam boilers.

"Permanent hardness," or that kind of "hardness" which remains after the water has been boiled, arises from the presence of the *sulphates* of lime or magnesia. It should be explained that by boiling we mean a temperature of 212 deg. F. This is too low to cause the sulphates to be precipitated; but if the water be heated to a little over 300 deg. F., it loses its power even of holding the sulphates in solution, and they are precipitated as well as the carbonates. As a temperature of 300 deg. F. only corresponds to a pressure of about 55lb. on the inch, and as this is almost invariably exceeded nowadays, it will be seen that the terms "temporary" and "permanent" hardness, as far as the feed water of a boiler is concerned, cease to possess any practical signification, and the salts, whether carbonates or sulphates, become slowly deposited upon the surface of the plates, sometimes as a fine impalpable powder, but more generally in the form of a hard scale, which is often exceedingly tenacious and difficult to remove.

As this scale is an exceedingly bad conductor of heat, its presence rapidly causes the efficiency of a boiler as a steam generator to deteriorate, and produces an effect upon the coal bill which no steam user can afford to ignore, and occasionally gives rise to serious trouble from overheating.

The methods of treatment hitherto adopted with feed-water impregnated with the salts of lime and magnesia, may be divided into two kinds, according as it is effected before or after the water is pumped into the boiler. The former includes such methods as the Porter-Clark, the Stanhope, and one or two other well-known processes, these being all more or less modifications of the well-known method of lime treatment first discovered by Clark for precipitating the carbonates. Their adoption, however, involves not only the occupation of a considerable amount of space, but also the expenditure of a comparatively large amount of capital in the first instance; so that although these methods prove fairly satisfactory where large quantities of water are dealt with, yet the trouble and expense attending their installation are so great as to deter the majority of steam users from adopting them, while there is the further objection to the Porter-Clark process that it is incapable of dealing with the sulphates, which sometimes constitute the larger portion of the salts in solution.

The difficulties in connection with the treatment of feed-water before its introduction to the boiler have led to numerous attempts to deal with the question of scale by the introduction into the boiler itself of anti-incrustation compositions. The

SEALE'S PATENT WATER PURIFIER.

CONSTRUCTED BY

MR. THOMAS BEELEY, HYDE JUNCTION IRONWORKS, NEAR MANCHESTER.

(For description see page 579.)

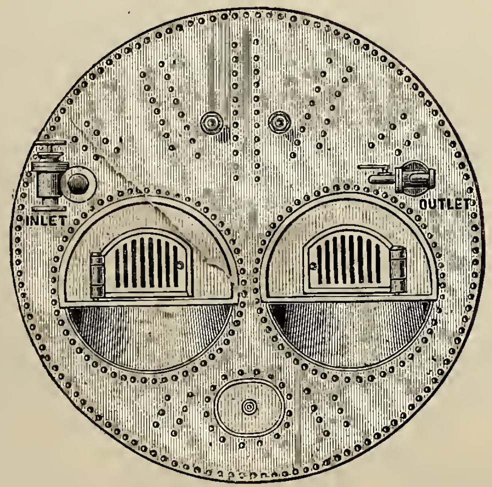


Fig. 1.—FRONT ELEVATION.

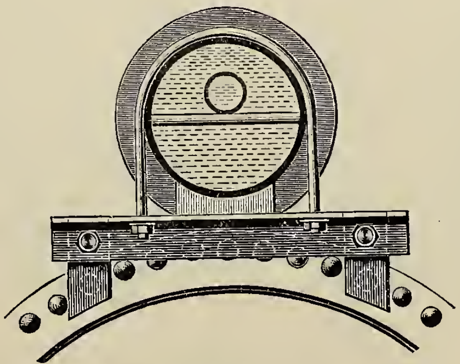


Fig. 4.—ENLARGED SECTION OF PIPE.

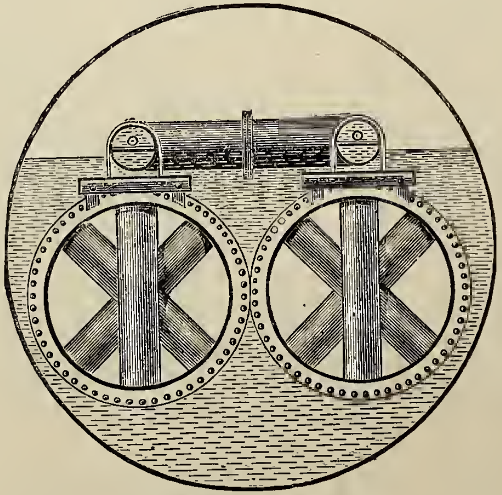
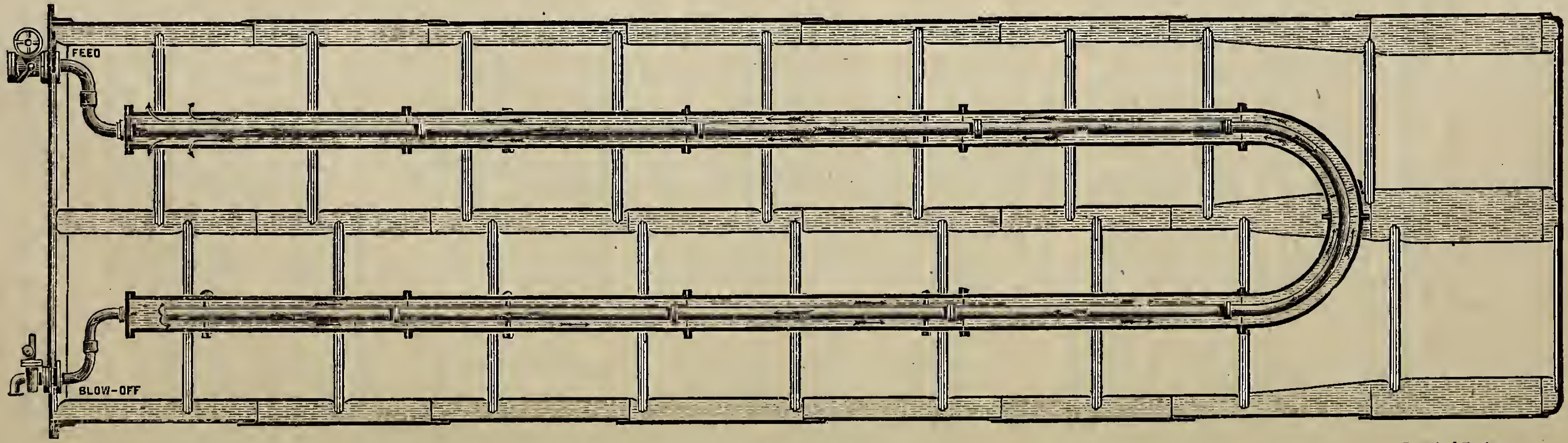


Fig. 2.—SECTIONAL ELEVATION.



Practical Engineer

Fig 3.—SECTIONAL PLAN.

EXPERIMENTAL TESTING OF MESSRS. J. BROWN AND CO.'S RIBBED AND GROOVED FURNACE TUBES.

(*For description see page 582.*)

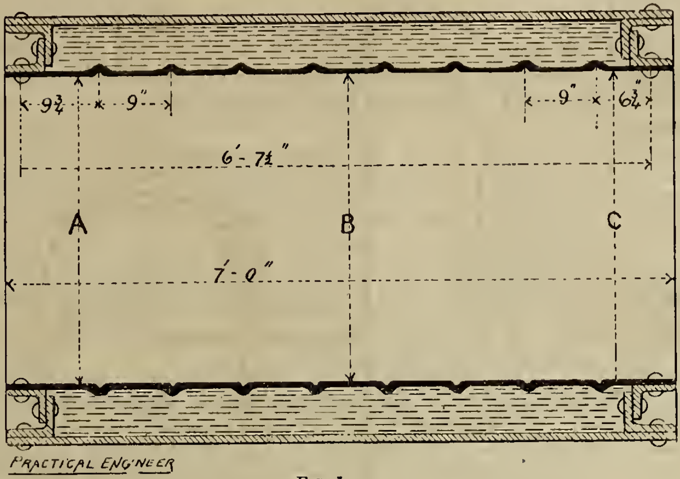


Fig. 1.

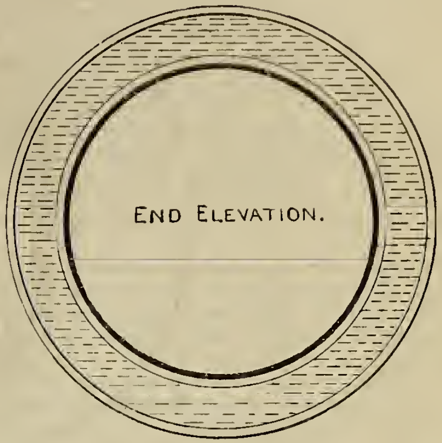


Fig. 2.

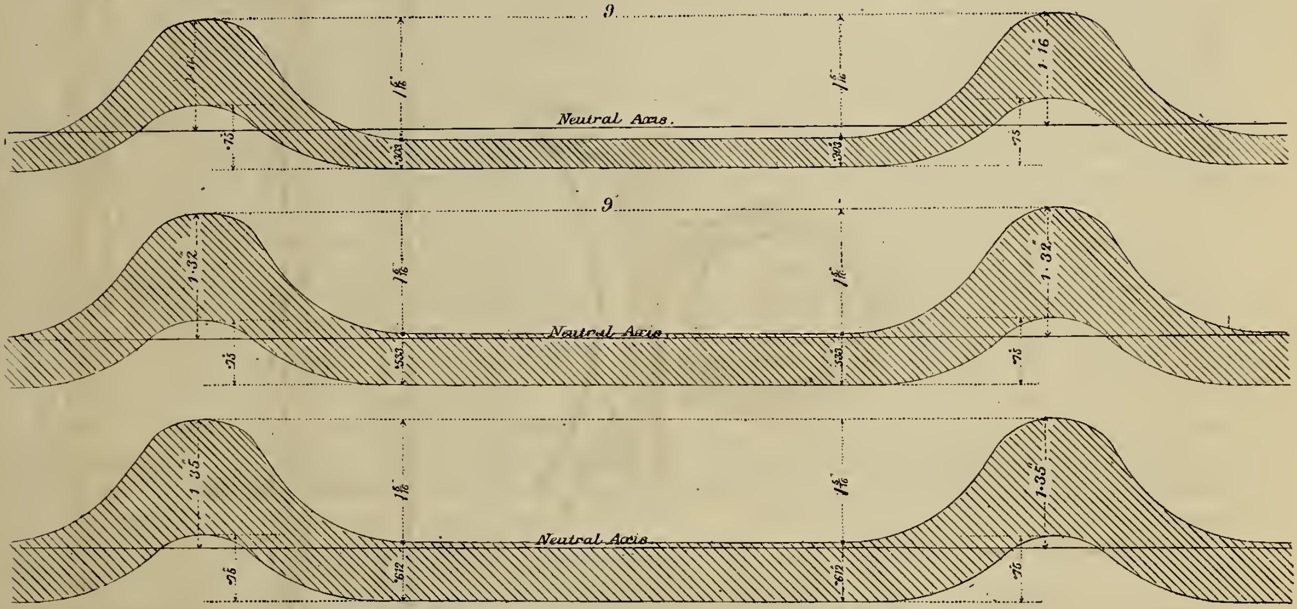


Fig. 3.—ENLARGED SECTION OF TUBES AND STRENGTHENING RIBS.

name of such compounds is legion, but the majority of them are worthless. Some undoubtedly exercise a beneficial influence upon the scale by rendering it softer and less tenacious, and thus more easy to remove; but they are all open to the objection that they deal with the impurities after the water is pumped into the boiler, whereas the primary object is to prevent the introduction of such impurities into the boiler altogether.

In the case of the boilers drawing their feed supply from rivers, the water, in addition to being impregnated with lime salts, is also liable to be more or less charged with earthy impurities held in mechanical suspension. Although mud does not form a scale so hard and tenacious as that due to the carbonates and sulphates of lime alone, yet its presence is very objectionable, as it interferes with the efficiency of a boiler and necessitates frequent cleaning and blowing out, while the amount may be so great as to render the water absolutely useless for boiler purposes. The only way of dealing with such impurities is by recourse to some process of mechanical filtration, and such a method alone leaves the salts of lime and magnesia untouched. We have dealt somewhat lengthily with the various impurities found in feed-waters in order that the difficulties encountered may be more fully realised, and the action of the apparatus illustrated on page 580 better understood.

Seale's water purifier is an apparatus that has been adopted in the United States for some time, and its working has been attended with such satisfactory results that we are surprised an earlier attempt has not been made to secure its introduction into this country, especially as its construction and mode of action are so simple and scientific. The illustrations given on page 580 show the application of this apparatus to an ordinary Lancashire boiler, fig. 1 being a front elevation, fig. 2 a cross section, fig. 3 a sectional plan, and fig. 4 a detail view showing mode of carrying pipe. As will be seen from the engraving, the feed enters through the feed valve at the front end in the ordinary way, and traverses through a length of about 50ft. of 2in. piping, arranged in the form of a horseshoe, as shown. This pipe, however, is carried inside a larger one (about 8in. diameter), suspended near the working level of the water, as shown in fig. 2, and the feed, after its passage through the small internal pipe, returns through the annular space between the two pipes along its former course to near its starting point, where it is discharged through slots into the boiler, as indicated by the arrows. From this description, coupled with the illustrations, it will be apparent that before the feed can mingle with the water in the boiler it will have become heated to practically the same temperature.

From what has been already said it will be evident that the first result of this increase of temperature will be to deprive the water, when it reaches 212 deg. F., of its carbonic acid, and thus liberate the carbonates of lime and magnesia previously held in solution, followed, subsequently, when a temperature of about 300 deg. F. is attained, by the liberation of the sulphates.

The water is estimated to reach this temperature shortly after its escape from the open end of the internal pipe; and as the outer pipe is of larger diameter and sectional area, the velocity of flow is correspondingly reduced, so that the annulus between the two pipes acts as a kind of settling tank in which the particles of lime and magnesia, whether in the form of carbonates or sulphates, are gradually deposited, along with any other earthy matters, as the water slowly travels towards the exit. The removal of any deposit which thus accumulates can be readily effected by opening the blow-off tap at the front of the boiler at the right hand, and by using this periodically the interior of the apparatus can be scoured, and the deposit prevented from accumulating or becoming adherent. As will be seen on reference to the illustration, the design of the apparatus is such that it can be readily applied to any existing boiler, and does not in any way interfere with access to the interior for the purpose of inspection or repair.

As compared with the ordinary method of treating feed-water by means of compositions, it will be seen that the apparatus possesses a decided advantage, inasmuch as the expense is confined to the initial cost of fixing, and does not involve a permanent weekly charge, as in the case of boiler compositions, while the expense of the apparatus, as compared with the external methods of filtration, such as the Porter-Clark, &c., is merely nominal.

We have had an opportunity of inspecting the results of the working of the apparatus under exceptionally trying conditions. The water was so heavily charged with lime salts and mud, that it was found quite impossible to use it alone for boiler purposes, the result being that the firm were put to a heavy annual expense in consequence of the large drafts they were compelled to make upon the town's supply. An idea of the quality of the water may be indicated by the fact that the impurities were found, on analysis, to amount to 70 grains per gallon. Rather more than one-half of this total consisted of sulphates of lime and magnesia in solution, the remainder being solid matter in mechanical suspension. After the application of the apparatus the source of supply was restricted to the impure river water—a course which had always given rise previously to considerable trouble from overheating and straining; but not the slightest trouble was experienced, and on examining the interior of the boiler at the end of three weeks' working, it was found comparatively clean, the deposit which had accumulated being insignificant in amount and easily removed.

Looking at the simple and effective method which Seale's purifier offers for dealing with one of the most vexed questions that harass a steam user, we venture to predict its wide and extensive adoption.

We should add that the sole right of manufacturing the apparatus for stationary boilers throughout the United Kingdom is held by Mr. Thomas Beeley, of Hyde Junction Ironworks, near Manchester.

EXPERIMENTAL TESTING OF MESSRS. J. BROWN AND CO'S RIBBED AND GROOVED FURNACE TUBES.

An interesting report has been issued by the Board of Trade for the benefit of its surveyors, of a series of experimental tests which have been conducted by Mr. Peter Sampson, one of the consultative staff of the Marine Department, to ascertain the strength of the patent ribbed furnace tubes which have been introduced by Messrs. John Brown and Co., Sheffield, and which are now being extensively adopted. The tests, which were made at Messrs. Brown's works, constitute a valuable supplement to those made by the Board of Trade a short time ago to ascertain the strength of furnace tubes stiffened with flanged seams, and to which we recently adverted in these columns.*

The strength of furnace tubes is a subject on which, as we have stated on previous occasions, engineers are far from possessing as full and exhaustive information as could be desired, though the Board of Trade have during the last few years added very much to our stock of knowledge in this direction, especially as regards tubes of short length.

The memorandum referred to, which is addressed to Mr. Thomas W. Traill, the engineer surveyor-in-chief, is as follows:—

Experimental Testing of Messrs. J. Brown and Co.'s Ribbed and Grooved Furnace Tubes.

Consultative Branch, Marine Department,
Board of Trade, Bedford Street, London, W.C.,
9th December, 1887.

Sir,—I have the honour to inform you that I have completed the testing of the second series of ribbed and grooved furnace tubes which Messrs. John Brown and Co., Sheffield, have had made in order to determine experimentally the resistance of tubes of that description to a cold-water pressure applied externally.

Description of Tubes.—The tubes, six in number, were nominally 7ft. in length over all, 38⅝in. in external diameter, and $\frac{5}{16}$in., $\frac{7}{16}$in., and $\frac{9}{16}$in. in thickness respectively. Each tube was made from a plate which had been rolled to the form and thickness required, except the two $\frac{5}{16}$in. tubes, the plates for which were rolled similar to the two $\frac{9}{16}$in. plates, and afterwards planed on the ribbed side to the required form and thickness. A specimen of each plate was sent to Messrs. David Kirkaldy and Son to be tested in accordance with my directions, and the results of these tests are given in the appendix.

Manufacture of Tubes.—Each tube was made as follows: The ends of the plate were first planed and bevelled outwards; the plate was then bent cold to the cylindrical form in a hydraulic press, after which the ends were fastened together at a distance of about ⅝in. apart, and into the opening thus left glut pieces of round bar iron were welded by the gas process. The plain parts were welded consecutively in this manner; then the ribs were similarly welded with glut pieces of larger diameter. At this stage the tube was taken to the annealing furnace, where, if the tube was not quite circular in cross section, the double operation of annealing and improving its form was accomplished. The latter process was of a somewhat primitive character, and consisted of putting the tube in a horizontal position on the floor of the annealing furnace, with its major axis vertical, and placing inside it two vertical wrought-iron bars of suitable length. These bars were temporarily fixed in the tube by the aid of loose bricks, and, as the crown of the tube softened by the heat, they prevented it from sinking more than was necessary to make the tube fairly circular in cross section. These bars were not removed until the tube was cold. The welding and annealing of all the tubes was done on behalf of Messrs. John Brown and Co. by Messrs. Pigott and Co., engineers, &c., Birmingham, which firm has had considerable experience in work of this kind.

Testing Arrangements.—The general arrangement of all the tubes was similar, and, with that of the apparatus in which the tubes were tested, is shown on figs. 1 and 2. It will be seen from the latter that each tube was 6ft. 7½in. in length between the centres of the inner rows of rivets by which it was secured to the end angles, that it was stiffened by eight ribs, worked out of the solid metal, and pitched 9in. apart, and that the centres of the two outer ribs were 6¾in. and 9¾in. respectively from the centres of the inner rows of rivets in the end fastenings. The ribs projected about 1$\frac{5}{16}$in. above the outer surface of the tubes, and were grooved on the inside to a depth of about ¾in. Approximate sections of the ribs are shown, full size, in the accompanying illustration (fig. 3).

The original internal dimensions of the tubes, as found by gauging the parts marked A, B, and C, fig. 2, are given in Table No. 1.

Table No. 1.

Distinguishing letter on Tube.	Nominal thickness of Tube.	Measurements taken at					
		A		B		C	
		Vertically.	Horizontally.	Vertically.	Horizontally.	Vertically.	Horizontally.
	Inch.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.
L	$\frac{5}{16}$	38$\frac{7}{32}$	38$\frac{2}{32}$	38 full	38$\frac{2}{32}$ full	38$\frac{6}{32}$	37$\frac{30}{32}$
K	$\frac{5}{16}$	38 bare	38 bare	37$\frac{31}{32}$ bare	38$\frac{1}{32}$ bare	37$\frac{27}{32}$	38$\frac{1}{32}$
J	$\frac{7}{16}$	37$\frac{28}{32}$ full	37$\frac{26}{32}$	37$\frac{16}{32}$ full	37$\frac{30}{32}$	38$\frac{6}{32}$	37$\frac{23}{32}$
I	$\frac{7}{16}$	37$\frac{28}{32}$	37$\frac{30}{32}$	37$\frac{25}{32}$	37$\frac{17}{32}$ full	37$\frac{24}{32}$	37$\frac{29}{32}$
H	$\frac{9}{16}$	37$\frac{18}{32}$ full	37$\frac{23}{32}$	37$\frac{13}{32}$	37$\frac{23}{32}$	37$\frac{18}{32}$ full	37$\frac{19}{32}$
M	$\frac{9}{16}$	37$\frac{23}{32}$ bare	37$\frac{20}{32}$	37$\frac{20}{32}$	37$\frac{9}{32}$	37$\frac{16}{32}$ full	37$\frac{25}{32}$ full

Table No. 2 shows the extent to which each tube deviated from the circular form at the parts gauged:—

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* See *Practical Engineer* for October 12th, 19th, and 26th, and November 2nd.

Table No. 2.

Distinguishing letter on Tube.	Nominal thickness of Tube.	Part where the measurements were taken.		
		A	B	C
	Inch.	Inch.	Inch.	Inch.
L	$\frac{5}{16}$	$\frac{5}{32}$	$\frac{2}{32}$	$\frac{8}{32}$
K	$\frac{5}{16}$	—	$\frac{2}{32}$	$\frac{6}{32}$
J	$\frac{7}{16}$	$\frac{2}{32}$ full	$\frac{14}{32}$ bare	$\frac{15}{32}$
L	$\frac{7}{16}$	$\frac{2}{32}$	$\frac{8}{32}$ bare	$\frac{5}{32}$
H	$\frac{9}{16}$	$\frac{5}{32}$ bare	$\frac{10}{32}$	$\frac{1}{32}$ bare
M	$\frac{9}{16}$	$\frac{3}{32}$ bare	$\frac{11}{32}$	$\frac{9}{32}$

The two $\frac{5}{16}$in. tubes are here shown to have been fairly satisfactory as regards form, but this cannot be said of the others, and it will be observed that tube J was deformed to the extent of $\frac{14}{32}$in. at the middle of its length, and $\frac{15}{32}$in. at the back end.

The pressure (hydraulic) was applied to all the tubes by a steam pump, and was registered by two of the board's pressure gauges that were made, and are used exclusively, for experimental purposes.

The pressure was increased by the increments shown in the tables containing the results of the tests, and immediately the gauges indicated the pressure required the latter was kept practically steady while the tube was being gauged for deformation. That end of each tube which had the greatest length of plain part is, in each case, called the front end.

Two gauges were used for detecting change of form, each of which consisted of an iron bar, sliding inside a tube having a set screw for binding the bar and the tube together; the length of these gauges was measured by a long steel rule suitably graduated. The following are the brief records of the results of the tests:*

Tube L, Nominal Thickness $\frac{5}{16}$in.—When the pressure reached 600lb. per square inch this tube collapsed locally at two places in the plain part of the front end. The bulges were situated at points 9½in. and 35in. respectively from the weld, and were of small dimensions. When the pressure reached 650lb. per square inch the plain part between the first and second ribs collapsed locally in two places, and there were also numerous smaller bulges in the other plain parts of the tube.

Tube K, Nominal Thickness $\frac{5}{16}$in.—When the gauges indicated a pressure of 635lb. per square inch the plain part between the sixth and seventh ribs of this tube collapsed at a point about 15in. from the weld; the plain parts at the back end and the two plain parts between the sixth and eighth ribs also bulged slightly near the weld.

Tube J, Nominal Thickness $\frac{7}{16}$in.—Just as the pressure reached 800lb. per square inch this tube collapsed from end to end, at about 14in. from the weld. The bulge was about ¾in. deep, and about 28in. broad, at mid-length.

From the general appearance of this tube it did not seem to have been as hot as the others when annealed, and, from the presence of a number of very fine lines on the side opposite the weld, I inferred that it had been bent in the press subsequent to its removal from the annealing furnace.

Tube I, Nominal Thickness $\frac{7}{16}$in.—This tube resisted a pressure of 800lb. per square inch while the measurements were being taken to ascertain the amount of deformation caused by the last increment of pressure; it then collapsed along both sides of the weld almost simultaneously with the act of releasing the pressure for the purpose of taking the set. The bulges extended from end to end of the tube, and were about 19in. and 24in. in breadth respectively at mid-length; the greatest depth of both was about ⅞in.

Tube H, Nominal Thickness $\frac{9}{16}$in.—At a pressure of 875lb. per square inch this tube collapsed from end to end at a distance of about 10½in. from the weld. The bulge measured about 27in. in breadth by $1\frac{1}{16}$in. in depth, at mid-length.

Tube M, Nominal Thickness $\frac{9}{16}$in.—At a pressure of 873lb. per square inch this tube collapsed throughout its length at a distance of about 14in. from the weld. The bulge measured about 16in. in length by about 1⅜in. in depth at mid-length.

(To be continued.)

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* Full and complete tables of the results were given in the report, but these are hardly of sufficient interest to quote *in extenso*.—Ed.

AN ENGINEER'S LIFE AT SEA.—XVIII.

BY A SEA-GOING ENGINEER.

As the third engineer is usually below while the "tops" are being overhauled, he may be curious to know what the "second" is about. For him the following may be of interest: Before arrival in port the "second" looks out the eye-bolts for the cylinder covers and gets the block and tackle in readiness on the top platform, with chain slings, shackles, and spanners. When work begins the firemen with him remove all the nuts, threading them in rotation on a length of marline, so that they can be put on as they came off. Then the three eye-bolts are screwed down through the cover, so as to force it upwards and break the joint. This prevents chisel marks round the edge of cover. With small engines the high-pressure cover is raised with block and tackle, all hands being on the rope, the end of which is passed down to the lower platform for the purpose. The low-pressure cover is usually raised by the travelling screw overhead. Should the high-pressure cylinder cover be removed on the same occasion, there may not be room to slide the latter along when hanging on the travelling screw so as to lay it down out of the way. In such a case the low-pressure cover may be laid hold of with another block and tackle, and slung upon its edge, there to be securely lashed. This will enable both pistons to be overhauled at once. If any heavy weights have to be laid on the platform, the engineer must first assure himself that it is strong enough. By laying planks along it, the weight may, however, be distributed, and the platform rendered safe. With a boiler tube laid along the platform, a block may be attached to lift, say a condenser door below. Every heavy weight should always be securely lashed, for in working cargo the ship may be listed to one side or the other from hour to hour, and in every case it is "better to be sure than sorry." Leaving heavy weights hanging at night or during the work is a dangerous practice. When working on the top, care must also be taken that nothing is allowed to fall, or it may alight on the head of someone. Such an "accident" has been known to occur when the one below was unpopular, though perhaps with no intention to injure.

The cover of the low-pressure cylinder being removed, the junk ring bolts are next got out, the engine having been turned on the top centre for the purpose. The "second" should not leave the men to start them, especially with a bright spanner in their hands, as they will be sure to mark it with the hammer. There should always be a black spanner, so made that a tube can be slipped on it to lengthen it, but failing this, one spanner can be made to catch in the jaws of the other so as to give more leverage. If an inexperienced "third" be set to hold the spanner while another strikes, he should give a strong pull when the blow comes on, so as to assist it, and also take up any back lash. Omission of this will cause his arms to tingle as with an electric shock. Or when the men are giving a pull on the spanner, a sharp horizontal blow with a hand hammer on the head of the spanner will usually start the bolt. He must hold the end of the spanner as low as possible to prevent slipping, and see that his hands are clear if it should slip. Such directions will not be wasted if they save the fingers of the inexperienced. With stubborn bolts a heavy hammer and a hard blow will be needed, and in this, as in all other cases, it will be found that one effective blow will succeed where a dozen of almost equal weight will fail. The junk ring and springs being removed, they are thoroughly cleaned with paraffin or turpentine, and the springs set out. With the usual short-curved springs, a blow or two with a round-nosed hammer on the inside—not outside—of the spring will effect this if a hard surface be below. This bruises the surface of the steel on the inner side, and, expanding it, straightens the spring. Previous heating is usually unnecessary, as these springs are never made so brittle as to break under the blow; if they do, it is time they were out. To clean the cylinder, the piston is turned down to the bottom of its stroke, and paraffin waste again used. As soon as the piston moves down, clear of the upper port, bagging is put in to fill it, and prevent anything dropping into the valve chest. The piston is finally turned to the top, and put together again. By working alternately at one and the other engine, both pistons can be overhauled with only one turning of the engines, and all particulars of the valves got by jotting down the lap, clearance, &c., in each position of the engines, though the turning may extend over several days. The delays of unnecessary turning must be avoided as far as possible.

The joint on the low-pressure cylinder is usually made of flat lamp wick, soaked in boiled oil, with red lead in solution, though sometimes the latter is dispensed with. By coiling the wick in a roll, it is easily run round the joint. Of course, every such joint must be made wholly within the circle of the studs, or there will be leaks from the stud holes in the cover. In putting down the cover, if it should by any chance be hung by the same eye-bolts which started it, these must be screwed back clear of the face of the cover. But by thus carelessly using these bolts for slinging, instead of the proper eye-bolts, they will certainly be bent each time they are used, and repeated straightenings will soon break them. In lowering the cover to its place, the "second" should see for himself that the joint is not disturbed after the studs have entered their holes. The cover being down, the men in tightening the nuts must go round them two or three times, if necessary. The "second" will, however, try them himself afterwards, and this knowledge makes the men more careful. It is an easy thing for a joint to start blowing on account of slack nuts, but not so easy to stop it while at sea.

Valve cover joints are usually made in the same way as their cylinder cover joints. The high-pressure cylinder and valve are most frequently jointed with red lead and marline. Where the red lead will not stick, owing to the face being greasy, the cure of "like cures like" is applied by rubbing the face with tallow, when the red lead will at once adhere. Where the face is badly scored, a flat gasket of spun yarn is sometimes platted and laid round, or a length of "tucks" sometimes, instead of marline. Lead wire is used, and makes a good joint. Some object to crossing the ends of the lead wire one above the other, but there is likely to be a leak if this be not done, and the resistance of the lead to crushing is infinitesimal compared with the power on the nuts. As soon as the engines are warmed up all nuts should be gone over again, for they will be found slack. Why they should be so is not at once apparent, for the cover should expand to the same extent as the studs. The strain already on the latter may have something to do with it, or the liquefying of grease, &c., on the studs. On these studs oil is rarely or never put, as it is credited with the burning away of studs. Some engineers keep the studs always dry; others use tallow, and this would seem to be harmless. Before closing up cylinders and valve casings a lump of tallow is usually put into each, but afterwards only cylinder oil is used. In closing up, besides making sure that all set-bolts are hard home, the greatest care must be taken that all sacking and tools are removed from cylinder and valve casing. It is said that on one occasion a launch engine was made in England, and partly put together before shipping to China; that the engine was there started, and at the first stroke knocked off its cylinder cover, when it was found that a hammer, by accident or malice, had been left in the cylinder. It was added that a new cylinder and rod had to be sent out from England to replace the damaged one.

In slinging cylinder covers there is always a much greater strain on the chain and eye-bolt than might be thought of at first, the strain being greater in proportion to the shortness of the sling chains. It can be made evident thus: Stretch a string tightly, and secure it well at the ends. A comparatively feeble pull on it sideways will be found sufficient to break it. In the same way, the wider the spread of the chain, the greater is the strain upon it. To calculate this, get the weight of the cover in pounds by multiplying its area in inches by its average thickness in inches, and this by 0·26. Take a third of this, as there are three chains, multiply the dividend by the length of chain from ring to eye-bolt, and divide the product by the vertical height from ring to cover. The reason of this rule is that the strain varies in proportion to the ratio between these two measurements. This gives the strain on the chain in pounds. We get the safe working load on the chain in tons by taking the diameter of its iron in eighths of an inch, squaring this, and pointing off the last figure as a decimal. Thus a $\frac{7}{8}$th chain is safe with 4 9 tons on it; an inch chain (eight eighths of an inch) is safe at 6·4 tons.

Ropes, being liable to deterioration, are not so easily calculated, but experience will enable an engineer to know almost exactly what safe load can be borne by any rope sling, and, almost unconsciously, he makes allowance for the fact that the doubled rope of a sling is not twice as strong as a single rope. On deck, as well as below, the young engineer will find many interesting problems about the weight which can be lifted by block and tackle, how much has to be allowed for friction, and how a side strain on the middle of a stay rope will affect its strength.

For the strength of ropes, the old rule was "four times the square of the girth in inches gives the breaking weight in hundredweights." Apparently, ropes are three times as strong now; and to get near the tabulated strength, take the square of the girth in eighths of an inch, and divide by 1,000, or point off the last three figures as decimals. The answer will be the safe working load in tons. This has an error of about 10 per cent on the safe side. The breaking strain is from five to seven times greater than this.

ALLOYS: THEIR CONSTITUTION AND PROPERTIES.—IV.

(Continued from page 545.)

The last lecture ended with a reference to the evidence which led Matthiessen to conclude that in certain cases the union of metals with each other must be attended with their passage into allotropic states. This is probably the most important generalisation which has hitherto been made in connection with the study of alloys, and I propose to devote this lecture to the consideration of this question of the molecular change in metals. It may be well to begin by a reference to some early views as to the constitution of metals, and I will ask you, therefore, to look at the surface of this mass of antimony which is adorned with a large crystalline star. An attempt to explain the origin of the star arose from a very early investigation into the structure of metals, and drew from Robert Boyle, in 1663, a protest against the supposition that "a certain respect to times and constellations is requisite to the production of this admirable body," as he called it. (Opera, Ed. 1772, Vol I., p. 325.) Lemery, a little later, in 1675 ("A Course of Chemistry," English Ed., 1686, p. 212), pointed out that "the star which appears upon antimony when it is well purified has given occasion to chymists to reason upon the matter. The greatest part of these men being strongly persuaded of the planetary influences, have not wanted to assert that this same star proceeded from the impression which certain little bodies flowing from the planet Mars do bestow upon antimony for the sake of the remaining iron that was mixed with it, and for this reason they wonderfully recommend the making of this preparation upon Tuesday rather than another day, between 7 and 8 o'clock in the morning . . . provided the weather be clear and fair." He adds: "My thoughts . . . shall not soar so high as these men's do; . . . I shall not search the celestial bodies for an explication of the star we now contend about, seeing that I can find it in causes near at hand . . . I say, then, that the star doth proceed from the antimony itself; the purification of the metal does serve to lay open the crystals of antimony, and the iron (it contains) by its hardness does expatiate these crystals." This attempt of Lemery to explain the development of a crystalline structure in a metal by the influence which the presence of a small quantity of a metallic impurity exerts will serve as a fitting introduction to the class of facts I want to bring before you to-night, the study of which has been much neglected, notwithstanding their importance in metallurgical industry.

All I can do is to set before you some evidence which may serve to throw light upon the question why a definite material actually employed in the manufacture of, say, a bridge or a weapon, can be depended upon to perform the duties entrusted to it, and why a certain other material would be absolutely untrustworthy, although chemical analysis can barely show the difference between the two. It has long been known that the properties of a metal may be influenced by the presence of a minute quantity of another element, even though it is so small as to preclude the possibility of its action being due to the formation of an ordinary chemical compound to which any reasonable formula, based upon atomic proportions, could be assigned. It by no means follows, however, that the atom of the added element does not exert a direct influence, or that its action is not controlled by a well-known law, but it is clear that in the experiment I am about to make, for instance, we are not dealing with the union of elements in atomic proportions. Here are two ladles containing exceptionally pure bismuth; they have been, as you see, filled from the same crucible containing the molten metal, and into one ladle I will introduce this tiny fragment of tellurium suspended above the molten mass of metal in one ladle. The contents of both ladles will be poured into moulds, and when the metal is cold it will be fractured. You will see that the bismuth to which the tellurium is added has become minutely crystalline, while that which remains pure has crystallised in broad, mirror-like planes, and one reflects a ray of light like a mirror, while the one containing the tellurium scatters the light. If we had no other guide than that afforded by mere inspection, you would say that the two masses were totally distinct elemental substances, and yet the only difference is that one contains $\frac{1}{2000}$th part of tellurium, and the other does not.

There are many such facts to be met with in practical metallurgy, and the knowledge of them has been steadily accumulating for centuries, but it is only since the end of the last century that it can be said to have been built up on a scientific basis, for it was not until 1781 that Bergmann discovered the wonderful fact that the difference between wrought iron and steel depends upon the presence or absence of a small quantity of carbon. The smallness of the amount of carbon capable of producing such striking effects greatly astonished him, and the chemists who followed him and repeated his experiments; but, strange as it may seem, the promulgation, in 1803, of Dalton's atomic theory threw a flood of light upon chemical phenomena, but cast into shade such investigations as those of Bergmann which dealt with influences of traces upon masses, and the authority of Berthollet was not sufficent to save them from neglect. In this eventful year for science, 1803, the latter published his essay on chemical statics, in which he stated, as a fundamental proposition, that in comparing the action of bodies on each other, which depends "upon their affinities and mutual proportions, the mass of each has to be considered." His views were successfully contested by Proust, but, as Lothar Meyer says, the influence on chemistry of the rejection of Berthollet's views was remarkable: "All phenomema which could not be attributed to fixed atomic proportions were set aside as not truly chemical, and were neglected. Thus chemists forsook the bridge by which Berthollet had sought to unite the sister sciences, physics and chemistry." Fortunately, however, in this country there was one chemist who had followed up the line of work indicated by the early metallurgists, for in 1803, the same year as that in which Berthollet's essay was published, Charles Hatchett communicated to the Royal Society the results of a research which he had conducted, with the assistance of Cavendish, in order to ascertain "the chemical effects produced on gold by different metallic substances when employed in certain" (often very small) "proportions as alloys." I shall subsequently refer to Hatchett's work.

Before we can investigate the nature of the action of traces of an element on masses of other elements, we must consider some facts bearing on the relation between atoms and molecules. Let these glass spheres which are spread out before you represent the atoms of which the molecules of an element are composed. If we could change at will the mass of the individual atoms, or if we could diminish or increase at will the velocity with which the atoms move, it might be possible to transmute one elemental substance into another, and the object of the alchemist would be realised. The progress of research may show that it is possible by a sufficiently high temperature, or by a suitable application of heat, to modify the number or forms of the atoms into which the molecule is split up, and in this way to resolve one elemental substance into another. At present we only know with certainty that we can change the grouping of the atoms in a molecule, but cannot alter the atoms themselves. That such change in the grouping of atoms is possible has long been known.

Berzelius made it clear that bodies having exactly the same chemical composition possess widely different chemical and physical properties. Here is a mass of black sulphide of mercury, here the red sulphide. Chemical analysis shows no difference between them, and yet their aspect is widely different. Many similar cases present themselves in the range of organic compounds, as Dr. Tidy has reminded us by a reference to narcotine and peperine, the former being the very substance to send you to sleep, and the latter to keep you awake, notwithstanding that composition is identical, although the grouping is different. To such bodies as the red and black sulphides of mercury the term isomeric is applied.

(To be continued.)

CORRESPONDENCE.

We do not hold ourselves responsible for the opinions of our Correspondents.

TRADE IMPROVEMENT AND OVERTIME.

To the Editor of "The Practical Engineer."

Sir,—Allow me to preface the subject matter of my letter with a word of compliment regarding the new series of *The Practical Engineer*, commenced with last week's issue. The change must, I think, be admitted by the most fastidious and exacting of your readers to be a very satisfactory one. It is with pleasure that I note your journal again steps to the front with valuable information on steam boilers; indeed, I find from my experience in various parts of the country that your journal is universally regarded as "the authority" on all practical questions relating to steam engineering. But I am wandering slightly from the subject matter of my letter.

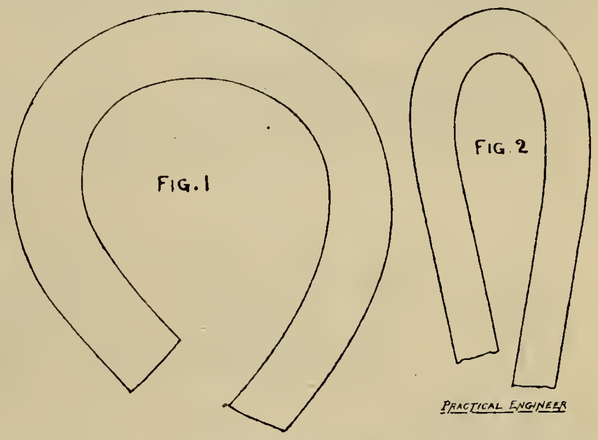
Your leading article in the last issue on "Trade Outlook for the Winter" is, I think, most encouraging and opportune, while its notes of warning, though they may sound harsh and shrill to a few, will, I think, by the majority of people be regarded as quite justifiable. It is encouraging to hear of the prevalence of an upward tendency in most of the markets, for this invariably means more wages earned and more money circulated. Your warning to firms about "raw haste" will, it is to be hoped, prevent the repetition of past follies, and I hope your remarks with regard to "systematic overtime" will be taken to heart. Many firms make a practice of this even when trade is slack, the employers in one particular trade being great sinners. When we hear of firms working overtime while a large portion of their plant is lying idle, we can, I think, hardly wonder at the action of trades unions in insisting upon some of the surplus labour being taken out of the market and off their funds. Overtime, to my mind, is to be deprecated as far as possible on moral grounds, for its indulgence prevents the workman from participating in the recreation and enjoyment to which he has not only a perfect right, but which is very essential to his health, and I firmly believe that many of our most promising artisans are in consequence of overtime converted into prematurely old men.

Apologising for having trespassed on your space, I am, &c.,
November 24, 1888. **Chalkline.**

PLATE BENDING TESTS.

To the Editor of "The Practical Engineer."

Sir,—In the article on the Birmingham boiler explosion, in your issue of November 9th, illustrations are given showing the results of bending tests made with strips cut from the plates of the exploded boiler. The results, no doubt, showed to those familiar with such tests that the plates were extremely brittle, but I think that the wretched quality of the plates would have been made more graphically manifest if you had given, side by side with the tests in question, further illustrations showing the results of bending tests, made in a similar manner, with good iron plates. I am aware that the percentage of elongation in the strip pulled asunder in a testing machine was given. But figures do not appeal so readily to the eye as a graphic illustration, and as the comparison I suggest may interest some of your readers, I enclose sketches showing the results of bending tests I have made with first-class iron boiler plates. Fig. 1 shows a sample of ¾in. plate, which was first bent cold round a fixed pin, and then closed with a hammer. Fig. 2 was a piece of the same brand, but only ½in. thick. The strips in each case were about 2½in. wide, and the edges of the strip were only rough sheared. Trusting I have not trespassed too far on your space, I am, sir, yours truly, **Ductility.**
Nov. 16, 1888.



QUERIES AND REPLIES.

Horse Power of Gas Engine.—Will some reader kindly afford me full information as to how I can obtain the horse power of a gas engine?—G. B.

Answer.—To obtain the horse power of a gas engine, an indicator diagram must be taken of the cylinder in the same manner as from a steam engine. The obstacles in the way of obtaining reliable diagrams hitherto have arisen mostly from the difficulty of obtaining an indicator which would stand the sudden shock of the explosion of gas, the high pressure generated, and the intense heat. If the indicator tap on the cylinder of a gas engine be opened when the explosion occurs, a bluish-looking flame, as a rule, is found to shoot out, and the intense heat of this, combined with the suddenness of the shock, has been found to speedily destroy any indicator of ordinary construction, by rendering it in a very short time almost red hot, &c. One mode which has been suggested of obviating the effects of the flame is to attach to the bottom of the orifice of the indicator cock a portion of platinum wire gauge to prevent the flame shooting up, on the principle of the Davy lamp. This has been to a certain extent successful, though the difficulties of obtaining a reliable and correct indication of the power of the engine have not yet been entirely overcome. The diagram illustrated is a copy of one taken from an Otto gas engine, with Kenyon's pistonless indicator, a special adaptation of which is apparently now becoming generally used for gas engines. The effect of the explosive shock shown on the diagram is but slight with the strong spring used, and the comparatively limited motion of the end of the Bourdon tube (which forms in reality the spring of the pistonless indicator) is shown on the figure by the kind of undulation or depression at A, made by the rebound of the indicator. The spring or tube apparently immediately recovers itself, and afterwards makes a steady curve, which is reproduced on letting the pencil run over the card almost any number of times. For the information of those who are not familiar with the manner in which a gas engine works, it may be explained here that one side of the piston is always exposed to the atmospheric pressure, so that the engine may be said to be single-acting, as the piston is only impelled from one side.

With the "Otto" gas engine, only one explosion can occur in two revolutions, the impetus given each time being sufficient to carry the engine through two complete revolutions. On examining the diagram, it will be seen at the commencement of the stroke that it bears the appearance of a steam engine diagram with the steam admission somewhat late, the piston having advanced from B to C before highest pressure is attained. The gas and air then expand while doing work down to D, when exhaust is opened, and pressure falls down to end of stroke E. Then return stroke commences, and propelling side of piston is exposed to atmosphere, the indicator pencil driving exhaust moving along atmospheric line GF. This completes one revolution. At the second revolution the propelling side of piston is still open to the atmosphere, and as the piston again advances, impelled by the momemtum of the flywheel, it fills the cylinder full of air. On reaching the termination of the stroke, communication with external air is closed, and on the return stroke again taking place, the air filling the cylinder is compressed into less and less space by the returning piston, as shown by the compression line from K to H, and the air and gas being then mixed at the pressure shown by height of point H above atmospheric line, in explosive proportions, the light is applied when the piston reaches the end of the stroke the second time. The pressure represented by height of point C above atmospheric line FG, is the result, and thus the cycle of operations is repeated.

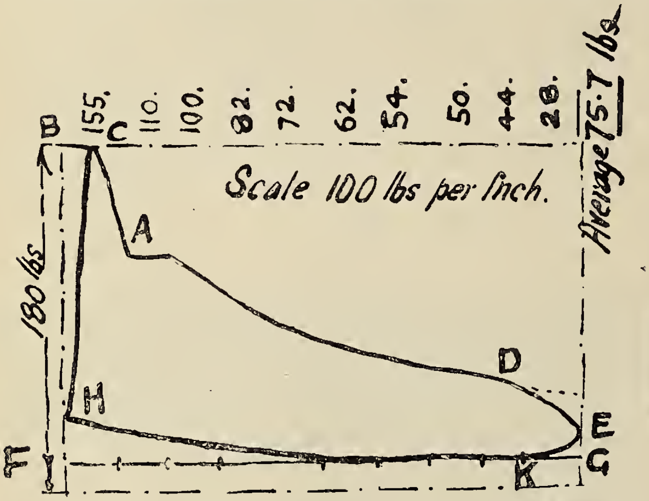
To compute the power, the diagram must be measured up either with the planimeter or by dividing it into ten parts, so as to find the mean average pressure exactly, as in the case of the steam-engine diagram. In the figure the average pressure measures up to 75·7lb. per square inch. It is well, in order to insure greater accuracy, to take, say four measurements across the first division, or tenth, in the portion about from B to A. We must, however, proceed somewhat differently to usual, in order to compute the "constant," which is the indicated horse power for each pound of average effective pressure.

In the ordinary steam engine, since the pressure acts at both ends of the cylinder, we double the length of the stroke, multiply the area of the cylinder by this, then by the number of revolutions per minute, and by the mean average pressure on piston throughout one revolution, and dividing this by 33,000, we obtain the horse power, or in formulæ thus:—

$$\frac{(\text{Stroke in feet} \times 2) \times \text{revs. per minute} \times \text{cylinder area sq. in.}}{33{,}000} = \text{I.H.P. for}$$

1lb. average pressure, or = "constant. "Constant" × lbs. average pressure shown on diagram = total indicated horse power.

In the gas engine the average pressure shown on diagram is not exerted twice in a revolution, as in the above case, hut only once every two revolutions; hence instead of doubling we must halve the number of revolutions. The cylinder of the engine from which the diagram illustrated was taken is 11½in. diameter, 16in. stroke, and runs 160 revolutions per minute; that is to say, the work shown by the diagram is only exerted 80 times per minute. Now, if this was an ordinary steam engine, we should havo 16in. stroke = 1·33ft. × 2 × 160 revolutions = 425·6 acting feet piston speed per minute; but as the piston of this gas engine is only impelled every other revolution, we shall only have one-fourth of the above piston speed as effective, thus: Single stroke 1·33ft. × 80 revolutions = 106·4 acting feet piston speed per minute. Taking the cylinder area, we have



Practical Engineer.

$$\frac{103{\cdot}87 \text{ sq. in.} \times 1{\cdot}33\text{ft.} \times 80 \text{ revolutions}}{33{,}000} \text{ or } \frac{103{\cdot}87 \text{ sq. in.} \times 106{\cdot}4\text{ft. per min.}}{33{,}000}$$

= ·336 "constant," or I.H.P. per lb. average pressure.

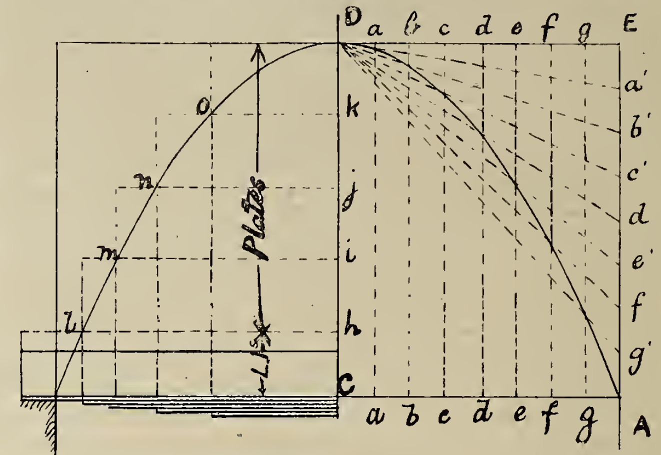
This constant or indicated horse power per 1lb. average pressure will be "constant" so long as the engine is fully loaded and the above speed maintained, the explosions occurring regularly every alternate revolution; and the "constant" only requires to be multiplied by the average or mean effective pressure, as shown in the diagram, to give the indicated horse power, which in this instance = 25·4.

$$\frac{103{\cdot}87 \text{ sq. in.} \times 106{\cdot}4 \text{ acting feet piston travel per min.}}{33{,}000} = {\cdot}336 \text{ constant}$$

× 75·7lb. average = 25·4 I.H.P. when the load is lightened, and the explosions occur at irregular intervals. A number of diagrams should be taken, and the averago number of explosions in a minute noted, in order to arrive at a correct computation of the power developed.—DRAUGHTSMAN.

DIAGRAM OF STRESS FOR GIRDER.—I should be obliged for any information regarding the most correct method of setting out a parabola for a uniformiy-loaded straight girder, supported at both ends, showing line of stress and how to fix length of plate hy same. One method I know is to draw the flange plates full size vertically, and make the central vertical line equal to the height thus obtained. But is there not another method of setting up the centre vertical line by taking the areas of the plates and angle irons consecutively?—GYRTONA.

Answer.—Herewith I send a diagram, which will, I think, give "Gyrtona" all he desires, trusting you may find spaco in your valuablo paper to insert the diagram, with description, as I feel sure it will be of use to your other numerous readers. Assume a girder 48ft. span, 4ft. deep, with a distributed load of 100 tons, then $\frac{W\,L}{8\,D\,5}$ where W = distributed load, L = span, D = depth of girder, and S = working strain per square inch; therefore, $\frac{100 \times 48}{8 \times 4 \times 5} =$ 30 sq. in. required at centre. To construct parabola, make C D equal to number of square inches required at centre of girder, viz., 30 sq. in. Draw D E parallel and equal to A C, divide D E and E A similarly; in this case eight parts, the end E of E A corresponding to the end D of E D. Through *a*, *b*, &c., in E D, draw *a a*, *b b*, &c., parallel to C D. Join D to the several points a^1, b^1, &c., in E A. The parabola will pass through the intersection of *a a* with D a^1, *b b* with D b^1, &c. The 30 square inches are made up by the following scantlings: No. 2, A 1s 3½in. × 3½in. × ⅝in., less rivet holes, = 5·46 sq. in.; and No. 4 plates, each 18in. × $\frac{7}{16}$in., less rivet holes, = 24·54 sq. in. = 30 sq. in. Set up on vertical line first A 1s = 5·46 sq. in. at *h* from the base at C. The adopted four plates being of equal area, the remaining height may be divided into four equal parts. The length of plates are determined where the horizontal lines drawn from points *h i j k* intersect parabola at *l m n o*.—TURNHAM.



Practical Engineer.

COMBINING INDICATOR DIAGRAMS.—Can any of your readers recommend me a book on indicator diagrams, from which I can obtain information concerning the combining of indicator diagrams of triple-expansion engines?—SHEERNESS.

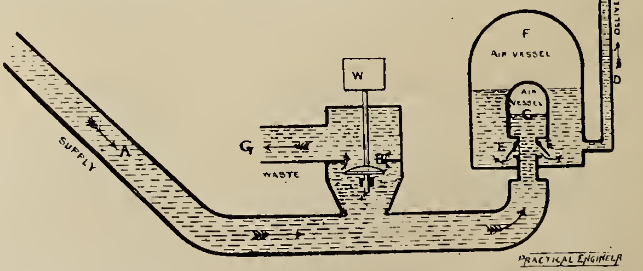
Answer.—In answer to the query of your correspondent "Sheerness," in last week's issue, regarding the combining indicator diagrams, I can strongly recommend a little book on the steam indicator by A.M.I.C.E., price 3s. 6d., publishod by the London Electrician Printing Co., Salisbury Court, Fleet Street.—G. T. PARDOE.

RUST JOINT.—Will you kindly tell me how to make an iron cement for steam pipe joints, one that will set quickly?

Answer.—A quick-setting rust joint cement may be made as follows: One part by weight of powdered sal-ammoniac, two parts flour of sulphur, eighty parts iron borings, made to a paste with water.

HYDRAULIC RAM.—Can any reader oblige me with a sketch and rules for proportioning a modern hydraulic ram, such, for instance, as the "Galiban" ram? I have studied the description of the hydraulic ram given in Rankine's "Prime Movers," but the sketch there given is very obscure, and I cannot follow the action of the waste water valve.—QUERIST.

Answer.—The principle of the hydraulic ram will be readily understood by a reference to the accompanying sketch. A is an inclined pipe conducting a stream of water from a reservoir; B is a valve which closes when it is lifted upwards. It is loaded with a weight W just in excess of the pressure due to the static head of water in the supply pipe, so that the valve opens in the quiescent fluid by its own weight, and allows the water to escape through the waste pipe G. The impetus of the water thus set in motion causes the valve B to close when the energy of the moving mass of water in the supply pipe forces the valves E E open and allows a small quantity to be forced into the air vessel F, and thence up the delivery pipe D, the quantity of water thus discharged depending on the head of water in the delivery pipe. The energy of the moving water heing thus absorbed, the valves E E close and the water becoming quiescent again, the valve B opens again under the pressure of the weight W, and the cycle is again repeated. The object of the air vessel F is to render the delivery of water from tho discharge pipe more continuous, while the small air vessel C serves to diminish the violence of the shocks. Information regarding the proportion of the apparatus will be found in "Molesworth." It is there stated that the length of the supply pipe should be not less than three-fourths the height to which the water is lifted, and that the apparatus is capable of raising one-seventh of the stream of water to four times the height of the supply, or one-fourteenth to eight times, and so on. Information regarding proportions is also given in ' Rankine."



Deterioration of Coal.—Could you or any of your readers tell me how much coal deteriorates by being stacked?—Xerxes.

Answer.—In answer to "Xerxes," I beg to state that coal deteriorates to a remarkable extent by being stacked where it is exposed to the atmosphere, not only by disintegration, but also by a loss of its heating properties. It is estimated that its power for raising steam is reduced in six months by being stacked and exposed to one-half of its usual power. This, of course, shows that to burn coal economically it should be brought into use by the consumer shortly after being raised from the pit. Coal thus exposed falls to pieces much more in the hot and dry months than in the winter. It is from the cause of this deterioration that the railway companies on every hand found it necessary to build coal depôts for storage purposes, when the serious destructive power of the atmosphere was considered.—D. Rushworth.

Answer.—That coals lose considerably in value by exposure to the weather is well known, but few probably are aware of the extent of the damage. Dr. Varrentrass has ascertained a loss of more than one-third in weight of a sample exposed for some time to the weather, and he states that the quality of the coal had undergone a still greater deterioration. The loss is due to slow combustion of the volatile elements of the coal, which gradually diminish in amount, whilst the proportion of carbon, ash, and sulphur are increased. Anthracite, as might be expected, suffers least from exposure to the atmosphere, and the bituminous coals are those which lose most.—F.

Paper Machinery and Manufacture.—Can any reader inform me whether there are any books published on the manufacture of paper and paper machinery, also the name of the publisher and price?—Boiler.

Answer.—"Boiler" will be able to select the most likely books to answer his purpose from the following list: "The Practical Papermaker; a Complete Guide to the Manufacture of Paper," by James Dunbar; price, 3s.; publisher, E. and S. N. Spon, 125, Strand. Also, by same publisher, "A Text Book of Papermaking," by C. F. Cross and E. J. Bevan; price, 12s. 6d. Another book is "Bamboo as a Paper-making Material," by Thos. Routledge; price, 2s.

Joy's Valve Gear.—I hope the question of "G. H." regarding Joy's valve gear will be fully answered, and if you could accompany the answer with a sketch it would, I think, be of interest to a many of your readers.—Japan.

Joy's Valve Gear.—Can any of your readers tell me how the valves are set in an engine when Joy's valve motion is adopted? Also, how to get the lead of valve? Suppose a valve to have $\frac{1}{4}$in. lead, and it is desirable to increase it to $\frac{3}{16}$in., how would you operate?—G. H.

Answer.—We have had several inquiries on this subject, and in reply to this, as well as to the query above, may say that we have in hand an article on the subject, to be accompanied with illustrations, which will, we think, answer everything that has been asked. We hope to insert this article in our next issue.

Concrete Floor.—Can any of your readers inform me as to the best way of preparing a concrete floor for a machine shop—the mode of mixing the cement, quantities, &c.?—Concrete.

Weighing Machines.—Is there any book published dealing specially with the construction of these machines, and what is the price?—T. D.

Setting Slide Valves of Marine Engine.—Previous to setting the slide valves of a marine engine it is customary, in the shop in which I am engaged, for those in charge to ascertain from the draughtsman the position of the eccentric sheaves on the shaft or coupling. The sheave is then temporarily fastened by set-screws, as it is sometimes apt to be moved slightly when the valves are being set. The instruction is to keep the sheave a stated distance or height from the shaft or coupling. A surface gauge is generally applied from the keep of the main bearing brasses, the difference of height from the coupling being taken into consideration. Will some reader enlighten me on this method; on what principle is it based?—Primrose.

Pitch Striker for Screws.—Will someone be kind enough to favour me with instructions for making a "pitch striker," or where the tool can be bought? The use of the tool is to obtain, with certainty, a true thread by the ordinary hand chaser.—A Fitter.

'Griffin" Gas Engine.—Will anyone who has had some experience with one of these gas engines kindly give me a few hints as to the management and cleaning of it? Also what number of lathes, 6in. centre, slotting and milling machines, I may work with a two H.P., without putting too great a strain upon it? What is the estimated consumption of gas per day of eight hours? Having lately purchased one, any information on the above points will be gratefully received by Fabricant d'Armes.

Ventilation of Mine.—Having noticed the questions and answers of "T. H. A." and "H." in *The Practical Engineer* of November 9th, regarding compressive ventilation of mine, may I ask how is this effected in the compressive system? Do they close the down-cast shaft at the top, and what kind of a fan do they use? Are there books on the compressive ventilation system?—Important.

Changing Currents in Dynamo.—I have a series of wound dynamo of the old Gramme type under my charge, working 19 large arc lamps, and I have found lately that both carbons have craters in the ends, showing that the current must have flowed alternately; and, if this be so, the polarity of the machine must have been constantly changing. Can any reader tell me whether this is a common thing or not, and if there is any remedy for it?—T. H.

TO CORRESPONDENTS.

Amateur Mechanic.—It is difficult to understand from your letter whether the steam is outside the discs and you want to keep it from getting between them, or whether the steam is admitted between the discs and you wish to prevent its escape. Till you make this clear we cannot insert your query; besides, you do not furnish your name and address, and we decline to respond to anonymous communications.

D. A., Edinburgh.—Your suggestion, we presume, refers to the stitching of the journal with wire. There are, however, serious objections to this, as it leads to the cutting of the paper. One of our contemporaries adopted that plan some time ago, but we believe it proved very unsatisfactory, and was shortly afterwards given up. Our large circulation, and the limited time available between printing and the despatch of the parcels, would render your suggestion impracticable even if there were no other objections.

Wakefield.—There is no association in England which grants certificates to engine attendants similar to those to which you refer, issued by the Glasgow and West of Scotland Engine-keepers' Association.

North.—Referring to your query regarding lift of valve, we fail to see where your difficulty lies. The expression you refer to simply states that when the lift is equal to one-fourth the diameter the area for escape is equal to the area of the pipe. If the valve is 4in. diameter, then a lift of one-fourth of 4in. is 1in., which is given by the expression you have quoted. Your method of working out the magnetic declination is quite correct as we understand it, assuming, of course, there are no temporary local disturbing influences to affect the needle.

D. J.—Swivel bearings are sometimes adopted in place of the ordinary brass step, so as to correct any inaccuracy in the alignment of the bearing and permit of even wear. Messrs. Hick, Hargreaves, and Co., of Bolton, have a patent bearing of this description, which they use for the crank shaft pedestals of their large engines, while Messrs. Lancaster and Tonge, of Pendleton, near Manchester, also construct a patent swivel bearing for line shafts. You had perhaps better make yourself acquainted with these arrangements before proceeding with the development of your ideas.

G. T. Pardoe.—The specification does not give details of the heating surface, and we could not say off-hand what amount of heating surface would be required in the four cases you mention. The evaporated efficiency depends, to some extent, upon the grate surface as well as the heating surface.

Engineer.—There is no legally constituted authority for granting certificates of competency to engine attendants on land, but we understand the Glasgow Engine-keepers' Association issue certificates to those who voluntarily submit themselves to an examination and satisfy them of their competence. See answer to W. S. H. in last week's issue.

J. D. C.—We cannot undertake to make an exhaustive analysis of indicator diagrams. To do so thoroughly would impose too heavy a tax upon our time. From a brief examination of the cards enclosed, however, we should say that they were fairly satisfactory. You do not in your communication favour us with your name and address, and we strongly object to respond to anonymous inquiries.

L.—We hardly feel in a position to offer you definite advice on the matter, but from what knowledge we have we should consider the salary you mention would be a fair one, and enable you not only to live comfortably, but also to save a little as well. We should not, however, think you would act wisely to accept anything less.

MISCELLANEA.

Large Wimshurst Electric Machine.—A large Wimshurst machine, similar to that made for testing the Deptford cable, is being made by Messrs. Mayfield, Cobb, and Co., to be sent to the Paris Exhibition. The machine has eight 30in. plates, and gives a spark of 12in.

Lord Armstrong's Birthday.—On Monday last, Lord Armstrong completed his seventy-eighth year. To his numerous friends it must be a source of the highest satisfaction to know that, notwithstanding his advanced age, he still retains so much of the freshness and vigour of his earlier days.

Paris to Constantinople by Train.—What is described as a *train de luxe* now leaves Paris every Wednesday at 7-30 p.m., and runs straight through to Constantinople without change, arriving at its destination on the Saturday at 5-35 p.m., so that the journey can be performed in 78 hours from London, and 70 from Paris.

A Long Tow.—The longest "tow" on record is about to be undertaken by the tug Stormcock, of Liverpool, the most powerful tug in Europe. She is *en route* to tow the Adencaple from Fernanda Noronha, near Pernambuco, a distance of 3,700 miles. The Stormcock has compound engines 26in. and 45in. diameter by 30in. stroke, and the boilers are worked at 100lb. She takes steel and wood to repair the vessel, divers, and a powerful steam pump.

Colliers' Wages.—A meeting of delegates, representing 50,000 colliers in South Wales and Monmouthshire, was held on Monday, at Aberdare, when the sliding scale, regulating wages, was adversely criticised, and a resolution was unanimously passed demanding an advance of wages, in addition to the 5 per cent recently granted, although the scale itself shows no such increase. The question was relegated to a committee, comprising workmen's representatives of the South Wales sliding scale board, with twelve other workmen.

Middlesbrough Iron Trade.—The prospects for next year in this district are said to be most cheering. In the manufactured iron trade there is more activity, and prices are better. A fair number of orders are in hand, and the works in operation in the north of England will be kept fully going for some months. The steelworks continue very busy, and several firms are making further extensions with a view to increasing their output. Engineers and shipbuilders have also plenty of work on hand.

Wages in the Shipbuilding Trade.—The shipyard men in the Hartlepools will, it is said, give notice on Saturday, December 1st, for an increase of wages at the beginning of next year, to the extent of $12\frac{1}{2}$ per cent. They state that last June they accepted a 5 per cent increase on piece work and 1s. 6d. per week on time wages, a promise being given at the time that a further advance would be conceded when circumstances permitted. The men consider that this time has now arrived.

The Halifax Gas Scandal.—William Carr, late manager of the Corporation Gasworks at Halifax, was charged before the borough magistrates, on Friday, the 22nd inst., with mutilating a certain book belonging to his employers, with intent to defraud. The case created widespread interest. Evidence was given showing that the prisoner had instructed a clerk under him to tear out of a press copy book 77 pages containing records of gas tests. It was stated that the amounts involved were very large. The prisoner was committed for trial at the Leeds Assizes, bail being fixed at £4,000.

The End of the Great Eastern.—What may be characterised as the last act in the career of the Great Eastern steamship was commenced at Liverpool on Tuesday, the 20th inst., when a three days' sale by auction of the entire vessel and her fittings was commenced. Mr. Dixon, of Liverpool, the auctioneer, announced that instructions were to proceed with the sale as per catalogue, which contained 893 lots. As a rule, satisfactory prices were obtained, convenient articles, suitable for mementoes, being in especial demand. The estimated quantities are 6,250 tons of iron, and 2,500 tons of woodwork, whilst the engines and boilers are over 1,500 tons more.

The Forth Bridge.—It is interesting to note that the Forth Bridge has most satisfactorily withstood the heavy gales that have been blowing during the last fortnight. A part of the timber staging and some of the wooden sheds, built to shelter the workmen, went down in the fury of the gale; but the steelwork of the bridge bore the buffeting without yielding. Travellers who recall the Tay Bridge disaster with a feeling of insecurity, will perhaps be more satisfied about the safety of the new bridge when they are reminded that it is calculated to bear a wind pressure of 56lb. per square foot, and that the recent storm beat against it in vain.

Imprisonment of Miners.—One hundred men engaged at the Halkyn lead mine, on the Duke of Westminster's Flintshire estate, had a terrible experience on Friday last, the 23rd inst. Owing to a breakdown of the winding engine, they were unable to return to the surface, there being no ladders in the shaft. They were eventually rescued, but not before they had traversed a drainage tunnel for a couple of miles, against a strong current, the water for the greater part of the distance reaching to their shoulders. The men were in an exhausted and pitiable plight when they came to land. Great excitement prevailed.

The Cornwall Railway.—The Great Western Railway directorate have concluded, subject to confirmation by the shareholders, the purchase of the Cornwall Railway, which they have leased and worked since 1861. The price paid was £8 for every £20 share. The purchase had been talked of for many years, and especially after the acquisition of the Great Western Railway's Bristol and Exeter section and the South Devon Railway. The absolute possession of the Cornwall line gives the Great Western an unbroken connection between Paddington and Land's End, and has probably been forced to an issue by the keen rivalry of the London and South-Western. By the purchase the Great Western Company add 65½ miles to their system, and bring their total mileage to 2,536. It should be stated that the Great Western Company had subscribed £202,500 to the share capital of the Cornwall line.

The Northumberland Coal Trade.—The only serious dispute which remains unsettled in the coal trade is that between the Northumberland miners and their employers. The miners suffered a reduction of 12½ per cent last year, and afterwards terminated the sliding-scale agreement which was founded upon the reduction. They now demand an advance of 15 per cent, and the owners have replied with an offer of 5. Meetings are now being held among the miners to consider the advisability or otherwise of accepting this offer. Should the offer be rejected, the relations between the miners and their employers will, it is said, assume a very serious aspect; but should the offer be accepted, an agitation will be kept up for a further advance, though it is not expected to assume a serious aspect before the brisk trade consequent on the opening of the Baltic in the beginning of summer commences.

King's College Engineering Society, London.—At a general meeting of this society held on November 13th, Professor Robinson, M.I.C.E. (dean of the Engineering Department), in the chair, Mr. Keith Robinson read a paper on "Compressed Air." The author commenced by pointing out the advantages of a central station for supplying power, and after enumerating a variety of uses to which compressed air may be put, he proceeded to a detailed description of the plant of the Birmingham Compressed Air Company. Provision was made at Birmingham for 15 triple-expansion air-compressing engines of 1,000 H.P. (indicated) each, but at present only three had been erected. The cylinder in which the air is compressed is surrounded by a water-jacket, by which means the heat developed in the compression is carried off. The mains and service pipes are laid in much the same way as gas and water pipes; at suitable intervals valves are fixed, consisting of a hollow metal or pith ball of such mass as to remain stationary under the normal pressure, but if a pipe should burst the rush of air to the break would be sufficient to blow the nearest ball into a socket prepared to receive it, and so shut off the broken section of the main from the rest of the system. The author then described the application of compressed air to the raising of sewage by Mr. Shone's system of ejectors, as carried out at Eastbourne and other towns, and after a brief reference to the pneumatic clock systems of Paris and Vienna, he concluded with a description of the plant of the Terni Steelworks, where compressed air is used entirely. In the discussion which followed, Professor Robinson—who in conjunction with Mr. John Sturgeon had carried out the compressed air works at Birmingham—said that with the water-jacket system the air was not exposed to water vapour in any way; the old method of cooling the air in the compressing cylinder with a spray of water led to the formation of ice on the expansion of the air. Professor Robinson then pointed out the advantage an air motor has over an hydraulic one in working expansively, and stated that the production of ice in motors might be prevented by rounding out the ports, and thus preventing the deposit of snow. After a vote of thanks to the author, and to Professor Robinson for taking the chair, the meeting adjourned.

The Ribble Navigation Difficulty.—On Saturday the Preston Corporation issued an analysis of the voting, when the poll of owners and ratepayers was taken as to whether the corporation should promote a bill in the ensuing session of Parliament to authorise them to borrow an additional £510,000 for the purpose of the Ribble navigation undertaking, in addition to £730,000 already expended. The votes were counted on the 13th inst., when it was found that there were 12,569 votes in favour of the application to Parliament, and 4,835 against it, a majority in favour of the bill of 7,734. The analysis of the votes shows that the immense majority of both large and small owners of property, as well as large and small ratepayers, are in favour of the promotion of the bill. The Ratepayers' Association, however, who successfully opposed an exactly similar bill last session, are preparing to oppose the application of the corporation again, on the ground that the scheme, as being carried out, is neither complete nor practicable. The result of the failure of the last application to Parliament was that the corporation were left without funds to meet engagements already entered into, and, as a consequence, Messrs. Fleming and Ferguson, of Paisley, have issued a summons claiming £7,218 15s., the amount of the second and third instalments due upon their contract with the corporation for a dredger.

SELECTED PATENTS.

APPLICATIONS FOR LETTERS PATENT.

November 16th.

16636 Gas Burners, G. S. Grimston, London.
16640 Copying Lathes, W. Smith, Birmingham.—[Complete Specification.]
16642 Tables, T. Lees and R. Lees, Hollinwood.
16643 Hoisting Heavy Weights, W. Turner, G. Fish, and G. T. Turner, Preston.
16653 Electro-motors, O. Fronly, London.
16658 Safety Junctions, T. Taylor and W. Tunnicliff, Birminghem.
16659 Adjustable Spanner, W. T. Hall, South Shields.
16669 Crushing Machines, F. Weidknecht and C. Schoeller, London.
16671 Iron and Steel, W. C. Roberts-Austen, E. J. Ball, and A. Wingham, London.
16673 Signalling, D. Macnee, London.
16679 Nails, H. H. Lake, London. (G. E. Buschick and F. Rautert, United States.)
16682 Hot-air Engines, C. Wells, London.
16683 Valves, W. Snelling, London.
16686 Bearings, W. J. Cocks, London.
16692 Tempering Cylinders, W. Anderson, London.
16695 Measuring Instrument, T. Green, London.

November 17th.

16696 Bearings, J. Seel, Manchester.
16699 Dough-kneading Machinery, J. Johnston, Manchester.
16702 Split Pins, J. Haywood, Barnsley.—[Complete Specification.]
16706 Screw Propellers, B. W. Maughan, London.
16708 Revolving Brush Machine, S Richardson, Sunderland.
16714 Machinery for Cords, W. T. Glover and E. Whalley, Manchester.
16722 Bending Racket Frames, T. Pitt, Bradford.
16723 Propelling Ships, G. A. Poole, Askern.
16726 Air Supply Pipes, J. Cooper, Manchester.
16727 Miners' Safety Lamp, D. L. Davies, Bristol.
16728 Dynamo Electric Machinss, N. G. Thompson, London.
16733 Preventing the Formation of Scales, J. T. Niblett, London.
16735 Sizing Metal Balls, W. Hillman, Middlesex.
16740 Railway Signals, I. A. Timmis, London.
16747 Discharging Coke Ovens, J. H. Cochrane, London.
16748 Cutting Rivet Heads, E. A. Cowper, London.
16753 Grinding Cements. A. Gray, London.
16754 Feed-water Heater, P. A. Guion and J. T. Knight, London.
16761 Condensing Steam, R. Reichling, London.—[Complete Specification.]

November 19th.

16773 Gearing, D. A. Murdoch, Belfast.
16776 Wood Screw Machines, G. Weber and K. J. Mayer, Barmen.—[Complete Specification.]
16778 Combined Machines, H. Spuhl, Berlin.—[Complete Specification.]
16790 Indicators, J. Atkinson, London.
16793 Oscillating Centrifugal Machines, J. Laidlaw, Glasgow.
16795 Stop Valve, St. J. V. Day, Glasgow. (P. S. Swan, India.)
16803 Supporting Device, C. D. Rogers, London.—[Complete Specification.]
16804 Cut-off Dies, C. D. Rogers, London.—[Complete Specification.]
16809 Voltaic Batteries, H. I. Harris and J. Garford, London.
16810 Lubricators, Tangyes, Limited, T. Jefferiss and C. W. Pinkney, Middlesex.
16811 Grinding Cement, W. Joy, Middlesex.

November 20th.

16836 Lubricating Mule, T. Thorp, Whitefield.
16838 Safety Device, H. J. Allison, London. (The Gas Engine and Power Company (Incorporated), United States.)—[Complete Specification.]
16839 Explosive Compounds, H. J. Allison, London. (C. W. Vanley, United States.)—[Complete Specification.]

Firms replying to advertisements inserted in our columns will do us a favour by mentioning the name of this journal in their inquiries.

Wanted, a Cornish Boiler, about 18ft. long.—Apply, T. D. Whitfield and Son, Apperley Bridge.

Wanted, 10 h.p. Boiler; with Galloway tubes preferred; must be equal to new.—W. N. Bundy, Whittlesea.

Wanted, 3½ h.p. Otto Gas ENGINE, in good working order; moderate price.—Cussons and Lyth, Leighton Street, Leeds.

Wanted, Horizontal Engine, 18in. cylinder; modern make; in first-rate condition; fullest particulars.—38, Heaton Lane, Stockport.

Wanted, an 8 h.p. Horizontal ENGINE; nearly new; state lowest price. George Parkinson, Contractor, Palmerston Street, Ancoats, Manchester.

Vertical Boiler Wanted, suitable for two puddling furnaces: also IRON CHIMNEY for same.—Thornhill Iron and Steel Company, Limited, near Dewsbury.

Punching & Shearing Machine WANTED, second-hand, in good order, to punch and shear ¾in. plates.—Address full particulars to Nicholson and Sons, Chemical Works, Hunslet.

Wanted, Good Second-hand WIRE ROPES, 1½in. to 2½in. circumference; also Hand DRILLING MACHINE and FLY PUNCH. Address, H., *Practical Engineer* Office, Manchester.

Wanted, a Single Colliery HEAD GEAR, and round Rope Pulley, about 35ft. high; Two Tee Bobs, for Pumping, about 9ft. centres.—Apply B., *Practical Engineer* Office, Victoria Station Approach, Manchester.

Planing Machine for Sale, 6ft. by 2ft. by 2ft.; or would exchange for Shaping Machine.—Forshaw and Son, Warrington.

For Sale, Soapstone Packings, RUBBER RINGS, ASBESTOS PACKINGS.—Address, H. W., *Practical Engineer* Office, Manchester.

For Sale, a Fine Massive Fly-WHEEL, 21ft. diameter, about 24 tons, centre boss, and built up in eight segments, 15in. hole; Hammered Iron Shaft, Carriages, and Heavy Brasses, &c.; also one set Whitworth's SCREWING TACKLE, complete, from ¼in. to 2in., equal to new.; to be sold cheap.—For particulars address, J., *Practical Engineer* Office, Manchester.

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Heavy or Light Planing and Turning done for the trade.—J. Chadwick and Son, Prince's Bridge Ironworks, near Ordsal Lane Railway Station, Manchester.

For Sale, Second-hand Boilers, 30ft. by 7ft. 6in., double riveted; 30ft. by 7ft., single riveted.—E. G. Constantine, 5a, New Brown Street, Manchester.

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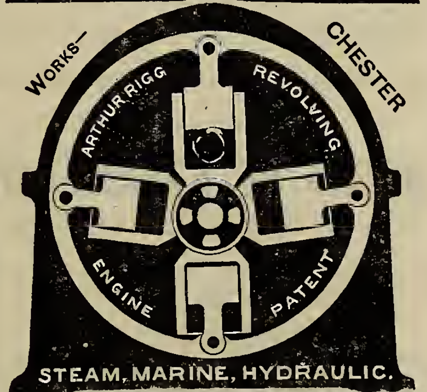

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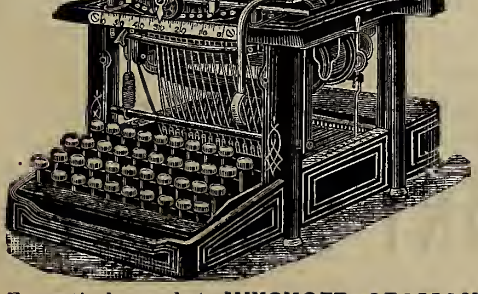

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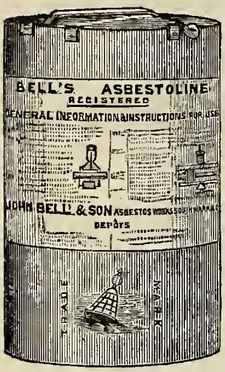
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BACK NUMBERS of "The Practical Engineer," from the commencement, can be obtained at either of our Offices in London or Manchester, or by order of any Newsagent.

Vol. I. (bound), containing Nos. 1 to 44 inclusive, from March to December, 1887, price 6s. 6d., can still be obtained by order from any Newsagent, or will be forwarded, carriage paid, from either of our offices on receipt of the amount by postal order or stamps.

Numerous complaints having been made to us by Subscribers of the difficulty they experience in obtaining copies of *The Practical Engineer* in certain districts, we have to state that the Journal can be obtained by any Newsagent through the ordinary trade channels, and no difficulty should therefore exist in obtaining copies *by order* of any Newsagent.

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EDITORIAL NOTICES.

All communications for the Editor of this Journal should be addressed to 6, Victoria Station Approach, Manchester.

Communications intended for insertion in the current week's issue should reach us not later than Tuesday Evening.

We cannot undertake to return rejected manuscripts or drawings unless accompanied by a stamped and directed envelope.

Contributors are requested to write on one side only of the paper. Sketches should be sent on separate sheets.

TO ADVERTISERS.

Advertisements intended for insertion in the current issue should reach our Manchester Office on Wednesday Morning *at the latest.*

THE
PRACTICAL ENGINEER.
DECEMBER 7TH, 1888.

THE NAIL AND SMALL CHAIN INDUSTRIES.

THE report of the labour correspondent of the Board of Trade, which was issued last week, is far from pleasant reading. It describes very minutely the state of the nail making and small chain industries as they are at present carried on in the Black Country. The condition of the workers and of their surroundings is simply disgraceful, but the evils are of so deep rooted—so radical a character—that it is far easier to point them out than to suggest remedies. These trades are confined to the villages occupying a limited area of South Staffordshire and East Worcestershire, where the making of nails has been carried on for generations in domestic workshops, in a patriarchal kind of fashion grandsire, father, mother, sons, and daughters in many cases all working together, the aggregate of their several small earnings being necessary for maintenance. Among these communities the difficulty of subsistence, always severe, is intensified by the employment of female and child labour; and by the existence of the truck system of payment, which it is stated still flourishes in spite of Acts of Parliament, while these evils are further aggravated by the increase of population, the pressure of German competition, the application of machinery, and the existence of the sweating system.

It is roughly estimated that there are about 15,000 nail makers in the district around Dudley, *half of whom are females.* Mr. Burnett describes the cottages and their adjoining shops as being small, dark and insanitary, reeking with abominable odours from overflowing sewage. Broken windows are stuffed with rags, a tidy house is an exception, and the general condition of the workshops and landscape is tumble-down and ruinous. It was so difficult in many cases to find the whereabouts of the cottages and shops that Mr. Burnett states he was glad to avail himself of the services of local guides, a fact which renders the Factory Acts largely inoperative in these districts. The shops contain bellows, small anvil and block, a few cutting and sharpening tools, a hammer, and the indispensable "oliver" or tilt hammer. The weight of the hammer varies from 10lb. to 30lb., and, as with other sections of the work, it is often operated by females. In specially heavy work males and females tread the hammer together, and the work is so laborious that the perspiration streams from their faces. "In many workshops may be seen young girls perched on beams above the heads of the men below, steadying themselves with the roof timbers, while with each foot they operate a bellows below." Women advanced in pregnancy, and mothers of families work in the shops to increase their scanty family earnings, their babies being suspended in boxes or chairs from the roof beams, or seated among the breeze beside the forge fire. No wonder that the women are pale and flat chested. The married women often work ten or twelve hours a day at the anvil to earn only from 2s. 6d. to 3s. per week, while the single women and the men frequently work much longer. Much of the female labour is of course illegal, but the women seldom see a factory inspector, and as he might try to shorten their long hours they are not anxious to do so, for that would mean a diminution of their miserable earnings. All work is paid by the piece, and strong men toiling 15 or 16 hours a day often fail to clear more than 9s. to 10s. per week at the utmost, after the necessary deductions for breeze and rent have been made, while the feebler men earn much less. Tea and bread, with margarine or bacon, form the staple articles of diet for this wretched population, while meat and potatoes are luxuries only obtainable in small quantities on Sundays.

Almost the same remarks apply to the chain trade, located about Cradley Heath, in which over 8,000 people find occupation. Men and women work indiscriminately at it, in the same shops, and in the same districts, and except in the large factories, the prices paid are little above starvation point.

As in other low paid trades, the necessities of the toilers create the class of sweaters, who fatten upon the miseries of their victims. The middlemen, termed "foggers," are the curse of the nail and chain trade. Labour being always superabundant and wages reduced to a mere pittance, the result is that when there is the slightest falling off in the demand for finished goods, the "foggers" buy at reduced prices of the people. The Truck Act is said to be evaded by the "foggers" or the wives of "foggers" keeping a provision shop, at which the people who part with their goods to these middlemen are tacitly expected to deal.

Mr. Burnett largely blames the isolated condition of the workers for this wretched condition of things, each individual fighting for his own hand, underselling or being undersold by his neighbour and fellow-toiler. Each man struggles but for himself and family, and thinks nothing of the common good, "and the prices of labour are thus subject to the daily haggle of workers competing for bread." He shows that in the chain trade, as carried on in factories, the operatives have not only shorter hours, but higher wages than those engaged in domestic workshops. In these establishments the wives and daughters are the competitors of their own husbands and fathers, and this, he considers, is the root from which nearly all the evils of the nail and small chain trades spring.

Mr. Burnett's report illustrates sadly the evils of disunion; of competition between men and women; of excessively low wages and consequent hand to mouth subsistence; and of the want of proper factory supervision.

He advises registration of all shops, classing domestic workshops as factories; and subjecting them to factory supervision. Uniform times of starting and of leaving work for all young persons and women; the publication of lists of prices to be hung up in all shops; the more rigid enforcement of the Education and Truck Acts; the appointment of a competent staff of local inspectors; and the extension of the inquiry into the sweating system by the present House of Lords Committee to these districts.

It is in this last suggestion that we should be disposed to place most hope. The lot of the people is so wretched that self-help seems almost impossible. But if the fierce light of publicity can be thrown on the degradation of women in the Black Country there is just a possibility that some ultimate amelioration of their condition may result.

SHIPBUILDING TRADE ON THE CLYDE.

The improvement in the shipbuilding trade on the Clyde which took place some months ago has been fully maintained during the past month, the contracts booked during this period making up a total of about 20,000 tons.

Of this sum Greenock has secured the principal share. Messrs. Caird and Co. have, it is said, contracts on for a Liverpool firm for two screw steamers, each over 3,000 tons, in addition to several other small orders. Messrs. Scott and Co. have also an order for a screw steamer, 3,000 tons, for another Liverpool firm, and have orders on hand amounting altogether to about 20,000 tons. The Caledonian Railway Company have placed an order for a large paddle steamer with Messrs. John Reid and Co., Port Glasgow, and through their marine superintendent have also purchased two other large river steamers. Messrs. D. and W. Henderson, of Partick, have contracted for the construction of a new steamer for the Allan Line Company's service. The Ailsa Company have, it is reported, secured an order for two vessels for the British India Steam Navigation Company, while Messrs. Napier, Shanks, and Bell have contracted to build a first-class passenger steamer for a Canadian firm, to ply on Lake Erie.

The number of vessels launched from the Clyde yards amounted altogether to twelve, with an aggregate tonnage of 21,251 tons. Nine of the vessels were steamers, while three were sailing ships.

When compared with the output in the corresponding months of previous years, the production shows a very marked and pleasing increase, being no less than five times greater than in the corresponding period last year—5,000 tons more than in November, 1886, and 9,000 tons more than in the same month in 1885. The total for the eleven months of the year so far is 245,214 tons. This exceeds by about 80,000 tons the production in the corresponding period in the three preceding years, and is only 9,000 tons less than in 1884, which was the last year in the previous spell of prosperity.

SIR HENRY ROSCOE ON HIGHER TECHNICAL EDUCATION.

Speaking at a meeting in the hall of St. John's College, Oxford, under the auspices of the Oxford Branch of the Teachers' Guild, on Saturday last, on the subject of technical education, Sir Henry Roscoe said that, looking to the fact that the majority of boys left school at twelve years of age without having definite employment, it was clear that the primary system of education failed to do the work which the nation required; and if this was so for the lower standards, how would it be if the State gave free education, not for the lower standards, but for the higher standards, and boys between twelve and fourteen? In his opinion they needed not only to systematise the secondary education, but above all they needed to place it upon a scientific basis. They must take care that if the artisan class was elevated by a proper system of training, those who were to occupy higher positions in the social scale were also equally well equipped for the work which they had to do. That was, indeed, to his mind the most important part of the whole subject. What was the use of training the workman if the foreman or master was ignorant? Hence the country which did the most to increase and develop its highest education was the one which, other things being equal, would win the race in national competition. These were the main ideas which influenced those who advocated the extension and development of technical education. They said there was a distinct function for the school and for the workshop to perform in assisting in this industrial equipment of the nation. The school ought to teach the principles, whether scientific or artistic, upon which the industry was based, and the workshop the practical and economical methods by which those principles were applied to the production of the best article.

MATERIALS OF ENGINEERING.—VIII.

Steel.

The treatment which steel undergoes after it has been tapped into the casting ladle varies according to its character. Except when required for castings, the practice, almost invariably, is to pour the metal into ingot moulds, and draw the ingots down, sometimes under the hammer, but generally in the rolling mill. The ingot moulds are massive tubes of cast iron, of circular or rectangular section, lined with a refractory material, and usually tapered in length for the free delivery of the ingot. The metal in the upper part is always honeycombed, and in the harder varieties shows a funnel-shaped depression or "pipe" when cool. To diminish this evil, and to preserve the chemical composition of the steel from becoming affected by oxidation, the mouths of the ingot moulds are "stoppered" immediately the metal is poured; that is, a shovelful of sand is thrown on the molten metal, is covered over with an iron plate, and wedged down. In spite of this precaution, the upper portion of an ingot is always unsound, so that from 30 to 40 per cent of its length has usually to be cut off in work requiring special soundness, as in the case of guns. This honeycombing is due to the presence of hydrogen and nitrogen occluded during melting, and liberated during cooling. These gases collect in the upper portion of the casting, chiefly in Bessemer and Siemens ingots, as well as at the sides, where the metal cools first. Various devices have been made use of in order to get rid of this evil, but with only partial success. Silicon, in the form of silico-ferro-manganese, has been added with advantage to the molten metal. Compression by gas has been tried. Baron Krupp has used carbonic anhydride; Sir Henry Bessemer proposed the use of a slow-burning powder. Steam pressure also has been employed. The best results produced as yet have been obtained by hydraulic pressure, as introduced by Sir Joseph Whitworth; the enormous pressures of from 6 to 20 tons per inch having been brought to bear upon the fluid metal. An ingot thus compressed shortens about 1½in. per foot of its length more than an ingot cast in an open mould.

If the ingots are allowed to become cold, they have to be reheated in a reheating furnace previous to rolling, the furnace being similar to that used for malleable iron. By the employment of the soaking pits of Mr Gjers the cost of reheating may be saved. These pits are built in brickwork below the floor, each pit being sufficiently large to receive an ingot, and covered with a lid to confine the heat. The result is that the excess of heat in the interior of the ingot becomes distributed equally throughout the mass, so that the steel is in a better condition for rolling than when the interior is almost molten and the exterior slightly chilled.

The rolling of steel is done in rolling mills similar to those employed for the similar operations on iron, but the process is termed "cogging," and the mills, "cogging mills." The piling and reheating required for iron is not necessary in the case of steel, the melting of the latter rendering it sufficiently homogeneous. The immediate products of cogging are termed "blooms," and from these the ultimate sections required are rolled.

If we ask what is the difference between malleable iron and steel, we are aware of a difficulty. If the distinction were one between crucible steel and malleable iron, we should point out at once that the first has a higher proportion of carbon than the latter, and will harden. But between the mild steels and the wrought irons this distinction does not exist. Hence the use of the terms "ingot iron" applied to the products of the Bessemer and Siemens furnaces, and the term "weld iron" applied to malleable iron. It is certain, in view of the rapid advances and refinements being made in the metallurgy of the iron compounds, some of our nomenclature will have to be revised. In the papers read by Mr. Hadfield before the Institution of Civil Engineers, early in the present year, on manganese steel, some very suggestive remarks were made relative to this matter. The writer quoted Bresson as saying that "steel is a particular state of iron produced by its union with bodies the nature of which can vary. There are three classes: first, steels composed of iron and carbon; second, those of iron, carbon, and a third body; third, those formed of iron and another body which is not carbon." At present the most generally received definition of steel is, that it is a compound of iron and carbon *which has been cast, and is malleable*, a definition which excludes cast iron, a material which is not malleable, and wrought iron, which has not been cast.

The chemistry of steel-making is still in an experimental stage. The beneficial influence of carbon, silicon, and manganese is beyond question, but the reasons of their operations are obscure. The art of steel-making consists in eliminating, as far as possible, the elements known to be prejudicial, such as phosphorus and sulphur, and in a lesser degree silicon, and so to proportion the carbon, manganese, and silicon as to produce the precise relationship required between strength, ductility, and soundness necessary for any particular purpose.

The effect of carbon is generally to increase the hardness and strength of steel, and to diminish its ductility. The point of saturation for carbon is found in the hard tool steels, in which the total amount never exceeds about 1·5 per cent, seldom more than about 1·1 per cent. In the mild Bessemer and Siemens steels the amount of carbon is often as low as 0·1 per cent, increasing to 0·2 per cent for plates, and 0·3 for rails. The mild steels, or those containing less than about 0·5 per cent of carbon, will not harden, this property belonging only to the more highly carbonised steels. The greater the range between the temperatures to which the steel is raised and quenched, the harder the resulting temper. On the other hand, mild steel, which will not harden, will weld readily, like wrought iron.

The influences of silicon, sulphur, phosphorus, and manganese on steel are very pronounced, so that the utmost care has to be exercised in proportioning these to tenths and hundredths per cent. For steel castings, where moderate hardness is not an evil, the addition of silicon to the extent of 0·2 to 0·3 per cent in the castings tends to prevent unsoundness; but mild steels should not contain more than ·02 to ·04 per cent, or hardness and unworkability will result.

Sulphur produces red shortness, and for metal which has to be forged, or worked at a red heat, should not exceed 0·01 or ·02 per cent. Phosphorus renders steel cold short, and ought not to be present in greater quantity than ·01 to ·04 per cent.

Manganese steel, properly so called, contains manganese, varying from 7 to 20 or more per cent. In ordinary steel, manganese in small proportions acts as a physic, improving steel which contains too much phosphorus, silicon, or sulphur, and increasing tensile strength and raising elastic limit. Hence it enters into the composition of all steels, and is purposely introduced in the form of spiegeleisen or ferro-manganese into all the steels made by the Bessemer and the Siemens processes.

J. H.

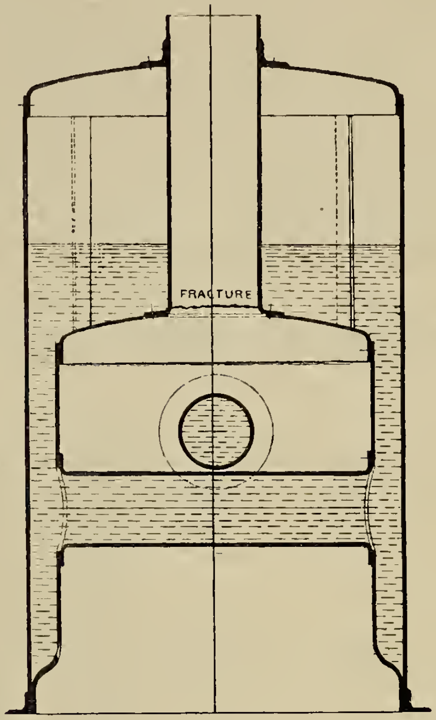
BOILER EXPLOSIONS.

Recent Board of Trade Reports.

(Concluded from page 575.)

The following sketch (fig. 1) shows the position of the primary rupture at the root of the uptake of the vertical boiler referred to in the Report of No. 282 Preliminary Inquiry in our last week's issue.

Fig. 1.

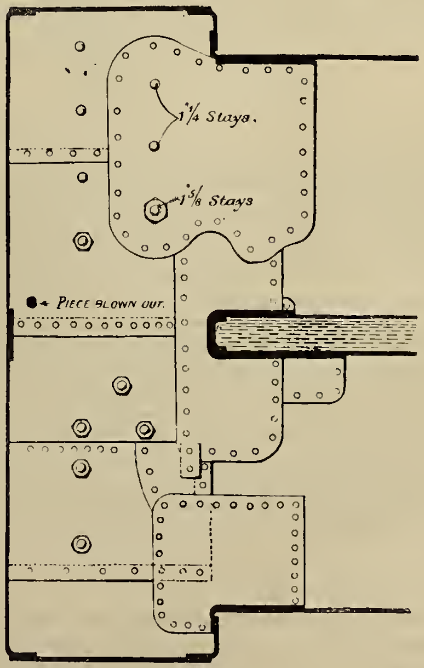


Practical Engineer.

Explosion of a Marine Boiler under Official Inspection.

Report No. 286 refers to the failure of the boiler of the steamship Weston, of Middlesbrough, on July 2nd, on her passage from Whitehaven to Maryport.

Fig. 2.



Practical Engineer.

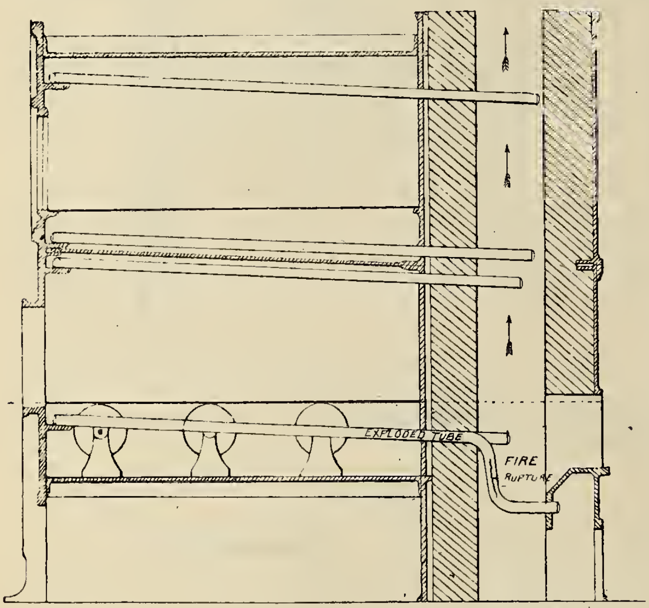
The boiler was of the usual cylindrical multitubular type, with two furnaces, and the failure arose from the blowing out of a small piece at the bottom of the combustion chamber, measuring 1¼in. by 1½in; through this opening the steam and water escaped, but no person was injured. The bottom of the combustion chamber appears to have been repeatedly patched, and the report states that as some of these became defective others had been fitted, until not much original plate remained. The ordinary thickness of the plates was $\frac{7}{16}$in., but at the time of the inquiry they are stated to have been reduced by corrosion to about $\frac{3}{16}$in.

As it is sometimes stated that the subjection of boilers to official inspection would serve to prevent all explosions, it is of interest to note that the one in question was examined so late as January last by one of Lloyd's surveyors, and was classed for the present year as A1 in Lloyd's Register of Shipping. Had the boiler been under the inspection of an insurance company, it would no doubt have been quoted by "carpet-bagging" philanthropists as indisputable evidence of their immorality and incompetence. We do not seek for one moment to reflect upon the good work that is done by Lloyd's, but merely take advantage of this opportunity to point out that equally good work is frequently performed by boiler insurance companies, for which very tardy, and in some cases no credit is given. The fact is, the best of men and the best of systems are at times liable to mistakes, and boiler explosions will never be *entirely* prevented by any scheme of inspection that may be devised.

EXPLOSION OF THE STEAM TUBE OF A STEAM OVEN.

Report No. 287 deals with the bursting of one of the pipes of a steam-heated oven, at Buxton, on July 9th. The oven consisted of a series of welded wrought-iron pipes, about 1¼in. in diameter and ¼in. in thickness, and fitted with solid welded plugs at the ends. The tubes were arranged in flat tiers, and each one held about 10½ cubic inches of water. The ends of the tubes projected at the back into a vertical flue, immediately over a fire, the lower row being bent down into the shape of the letter Z, so as to form the fire bars. It was from the failure of one of these bent tubes that the explosion arose. There was no means of escape for the pressure generated, which depended simply on the temperature to which the ends were raised. The makers of the tubes stated that they tested them before finally welding the end to 6,000lb. on the square inch. The tube which gave out was ripped open on both sides, the fracture following the weld on one side, and going through the solid metal on the other. There can be no doubt that the immersion of the end of the tube within the fire would lead to its being seriously overheated and weakened, so that the hydraulic test would be no measure of its bursting strength.

FIG. 3.



Practical Engineer.

FAILURE OF UPTAKES ON FISHING SMACKS.

Reports Nos. 288 and 289. These cases are somewhat similar to those referred to in Reports Nos. 281 and 285. Both occurred on fishing smacks in the North Sea, and both on August 9th.

The failure in each case was due to the uptakes of the boilers, which were of the vertical type, being corroded through in the steam space above the water line. The holes formed, however, were extremely insignificant, the diameter in one case being only equal to that of a threepenny piece.

The only feature in connection with the cases worthy of comment is the indication they afford of the tendency of the uptakes of these small boilers to rapidly waste away, in the manner we have described in preceding cases.

Report No. 290 refers to an explosion which occurred at Birchills, Staffordshire, on August 28th last.

The boiler, which was used to supply steam to a small engine which worked a chaff-cutting machine, was of the plain cylindrical type, with flat ends fixed externally. It measured 7ft. in length by 3ft. in diameter, the cylindrical portion being composed of two plates $\frac{5}{16}$in. thick, while the flat ends, which were each in one plate and flanged at the circumference for attachment to the shell, appear to have been originally $\frac{7}{16}$in. thick. The explosion arose from the blowing out of the back end plate, which was torn all the way round at the root of the flange. On the failure of the end plate the boiler was shot from its seat against the wall of a dwelling-house, which was seriously damaged, while the brickwork setting and chimney were demolished. Several persons who were near at the time were, it is stated, slightly injured. The failure of the end plate was due to the formation of a groove caused by the continual fretting action arising from the alternate breathing of the end plate under alternations of pressure. The fretting action had no doubt been going on ever since the boiler was laid down, about eight years ago, and the plates at length became too weak to sustain the ordinary working pressure, which appears to have been 25lb. on the inch.

Report No. 291 refers to a case of scalding which occurred, on September 7th, on a locomotive belonging to the Islip Iron Company, Thrapston, Northamptonshire, and arose from the blowing out of a plug, which had been driven into the firebox tube plate as a temporary expedient, with a view to stop a leaky tube. At the time of the occurrence the pressure was said to have been about 125lb. on the inch, and four persons who were on the footplate of the locomotive at the time were scalded, three of them somewhat seriously.

THE FIRST RAILWAY IN CHINA.

WHAT may be regarded as the first railway in China has just been completed. The line, which is 86½ miles long, joins Tientsin and the port of Taku with the great coal region around Tong-shan, where the new Kaiping colliery is situated. It may be regarded as the beginning of what promises to be eventually one of the largest and most profitable railway systems in the world.

The line, it should be stated, has been entirely built by the Chinese, under the superintendence of Mr. C. W. Kinder, C.E., who is well known for his work in railway laying in England and America. There were not many unusual engineering difficulties encountered in its construction, the greatest being the crossing of the river Peh-tang, and in traversing several swampy sections.

The land being as flat as Holland, and very subject to floods, provision had to be made for a part of its length to meet the rising waters of the Pei-ho and other streams. This was done by simply raising the line in the most water-threatened places about 8ft. above the surrounding country; and in one section, that between Peh-tang and Hanku, which suffers frequently from inundations, four fine bridges and a flood-opening had to be provided in a distance of under eight miles.

There are many other splendid bridges among the fifty along the line, one especially at a place called Chung-hang-Chang, built in America, and forming a very handsome, light, though strong structure, with a span of forty yards, which can be widened by a peculiar arrangement to admit a double line when it becomes necessary. The line, it should be here mentioned, is for the greater part a single one, worked on the American "bogie" system, with loops at the stations. So far there has been no serious opposition to the railway, except in isolated cases, where it is said to have been promptly stamped out by a judicious administration of the bamboo. The owners of graves, which constitute perpetual stumbling-blocks all over China, made some trouble here and there, but the imperial edict had gone forth, and it was no use fighting against the officials, who offered compensation for the right of way for the line, and the people in most instances took what they could get.

NEW TORPEDO BOATS.—The Government have placed in the hands of a Bolton machinist firm an order to fit six new torpedo boats with boilers of from 1,000 to 1,500 H.P. The new boats are being constructed on improved methods, as suggested in the report on the recent naval manœuvres.

LAUNCHES AND TRIAL TRIPS.

On Wednesday, the 28th ult., a new steel screw steamer, Margherita, built by Messrs. Scheslinger, Davies, and Co., Wallsend-on-Tyne, to the order of Messrs. Leech, Harrison, and Forwood, of Liverpool, was taken to sea on trial. The vessel has been built to the highest class at Lloyd's, under special survey, and is fitted with all the most modern appliances for the rapid loading and discharging of cargo. The principal dimensions are: Length between perpendiculars 170ft., breadth, moulded, 26ft., depth, moulded, 13ft. 4in., with a dead-weight capacity of about 700 tons. The engines have been built by the North-Eastern Marine Engineering Company, Wallsend, and are of the triple expansion type of 75 N.H.P., with cylinders 14in., 23in., and 39in. by 27in. stroke. The engines worked with great smoothness, and gave every satisfaction to those on board, and in spite of the very heavy weather a mean speed of 10½ knots per hour was attained. The vessel has been purchased by Messrs. Walker and Co., of Venice, and the steamer will be taken out to Venice with an Italian crew.

On Tuesday, the iron screw-steamer Orestes, built and owned by Messrs. Schlesinger, Davies, and Co., Wallsend-on-Tyne, was taken to sea for a light trial. The vessel has been built in the highest class in the Liverpool Registry, and is fitted with all the latest improvements for the rapid loading and discharging of cargo. The principal dimensions are as follow: Length between perpendiculars, 260ft.; breadth, moulded, 36ft.; depth, moulded, 20ft. 2in., with a dead-weight capacity of about 2,400 tons. The engines have been built by Messrs. Black, Hawthorn, and Co., Gateshead-on Tyne, and are of 160 N.H.P.

The new steamer, Lady Martin, recently launched from the shipbuilding yard of Messrs. Workman, Clark & Co., of Belfast, and built for the British and Irish Steam Packet Company, Dublin, was tried for speed on Thursday, the 29th ult., between the Cloch and Cumbrae lights, when she attained a speed of 13½ knots per hour, with 1,250 tons deadweight on board and in very unfavourable weather. The Lady Martin is a vessel of 1,250 tons, and is of the following dimensions, viz.: —Length between perpendiculars, 270ft.; breadth, moulded, 34ft.; depth of hold, 16ft. 6in. The machinery, constructed by Messrs. Dunsmuir and Jackson, Govan, is of the triple-expansion type, and is finished in a first-class manner. The boilers are two in number, double-ended, and are fitted with Fox's patent corrugated furnaces. They are entirely constructed of steel, and for a working pressure of 160lb. per square inch. The vessel is fitted throughout with the electric light, and the saloon and state-rooms are fitted up in a sumptuous manner for passengers. The hull and machinery have been constructed from the designs and under the superintendence of Mr. A. F. White, the company's superintendent engineer.

On Saturday the Fairfield Shipbuilding and Engineering Company launched a large transatlantic liner of about 4,500 tons, for the Norddeutcher Lloyd, of Bremen, which had been built in the remarkably short time of less than one hundred working days. The following are the principal dimensions of the vessel, which is named the Dresden: Length over all, 405ft.; breadth, 46ft. 6in.; depth, 33ft. She has been constructed in accordance with the newest regulations of the Germanischer Lloyd, under their special survey, and will be classed in the highest grade of that society. She also conforms in every respect to the Board of Trade regulations, and to the latest requirements of the United States. She is built throughout of Martin steel, and has two water-tight steel decks all fore and aft, poop bridge-house, and topgallant forecastle. The weather and upper decks are of teak, and the deck-houses are of steel and teak. When complete the vessel will have accommodation for about 40 first-class, 16 second-class, and about 2,000 third-class passengers, besides ample accommodation for the officers and crew. The Dresden is lighted throughout with electricity, for which purpose she has two distinct engines and duplicate dynamos, each furnishing power of about 300 incandescent lights. The vessel will be fitted with surface condensing engines of the triple-expansion type, having three inverted cylinders; the diameters respectively are—high-pressure 30in., intermediate 50in., and low-pressure 80in., each adapted for a piston stroke of 4ft. 6in. The high-pressure cylinder is fitted with a piston valve, and the medium and low pressure cylinders with double-ported slide valves. The crank shaft is built, and, together with the propeller shaft, is made of Vickers, Sons, and Co.'s steel. The tunnel shafts are of Siemens-Martin steel, and were supplied by Messrs. John Brown and Co., Sheffield. The engines are fitted with all the latest improvements for economising fuel, including a feed-water heater, a fresh-water producer for the boilers, &c. The propeller boss and blades are of cast steel, the latter being coated at the back by Johnston's process. The steam required for working the engines will be generated by two double-ended steel boilers and one single-ended auxiliary boiler, fitted with corrugated furnaces.

GASEOUS FUEL.

At a meeting of the Halifax Literary and Philosophical Society, on Tuesday Dec. 4th, Mr. B. H. Thwaite, C.E., F.C.S., gave a lecture on "Gaseous Fuel and its Uses." After referring to the incalculably evil effects of smoke-production on health, and the extraordinary waste resulting therefrom, he showed, by scientific arguments, that no remedy except the use of gaseous fuel would be effectual in removing the evil. The extraordinary development of the application of natural gas in Pennsylvania was described. The lecturer pointed out that, from geological premises, he is of opinion that, some 1,500 feet beneath the salt beds of Cheshire and other salt districts in this country, natural gas might be found; and, had we had the enterprising spirit of the Americans, not only the salt fields but the coal fields of this country would have been prospected and drilled ere this.

The scientific processes involved in the generation of gaseous fuel from coal and oil were fully described, and Mr. Thwaite showed, by plans, a scheme for supplying gaseous fuel to London from the South Wales, Staffordshire, and South Yorkshire coal fields. The mains would be four in number from Staffordshire, for a length of 120 miles.

The South Wales branch main would consist of two pipes, 100 miles in length, and the South Yorkshire branch one pipe of 70 miles in length. Branch pipe-lines would supply all the principal towns between Barnsley, Stafford, and London. The coal would be converted into gas at the coal fields and delivered to the mains under great pressure, and could be distributed in the towns in the daytime for heating purposes by the ordinary mains; and could also be used at night for illuminating, with special burners.

The saving in fuel by this distribution system would be colossal. There would be no cartage nor railway carriage. The gas would flow from its source to the position of use. There would be no middle-men. The saving in London alone would realise an immense figure; and the smoke question would be settled once for all, with a benefit to the inhabitants of this country that would surpass the effect of all the great achievements of sanitary and economic science.

Mr. Thwaite pointed out that natural gas is conveyed 60 miles from the wells in Pennsylvania to distributing locations, and that within the last few years the mileage of distributing pipes has increased from nil to 2,300 miles. Mr. Thwaite described a scheme for conveying gaseous fuel to the large towns in Lancashire from the Wigan coal field; and in the West Riding of Yorkshire from the Barnsley coal field.

THE INSTITUTION OF CIVIL ENGINEERS.

At the third ordinary meeting of the session, on Tuesday, the 27th of November, the President (Sir George B. Bruce) being in the chair, a paper was read on "The Witham New Outfall Channel and Improvement Works," by Mr. J. Evelyn Williams, M.Inst.C.E.

The Author stated that in 1878 he was instructed by the Witham General Commissioners to report upon the improvement of the river Witham. He then found the outfall, or tidal portion of the river, most unfavourable, both for drainage and for navigation. A tide which rose 21ft. in Clayhole, in the estuary of the Wash, only rose 12ft. 6in. at Boston. The lower reach of the channel, between Hobhole Sluice and the estuary, was not only shallow and circuitous, but untrained and broken through a mass of shifting sands. The flood-waters rushing seaward cut frequent and successive "steeps," from 10ft. to 12ft. in height, which kept tumbling into the channel and choking it up; the channel thus became distorted, and sometimes shifted a mile from east to west in a few weeks. The flood-tide from the estuary swept over these shifting sands, and flowed like a rapid wave up the river to Boston, carrying a large quantity of sand in suspension. This was deposited during slack tide in the upper reach of the outfall, where in dry seasons, during the absence of the fresh-water scour, the deposit reached the level of 11ft. 6in. above the sills of the Grand Sluice in Boston, and rendered the flow of neap tides insensible at the sluice. It was ultimately decided that the General Commissioners should promote a bill in Parliament, and in the ensuing session the River Witham Outfall Improvement

Act, 1880, was obtained. Under this Act the Witham Outfall Board was constituted, and on the 14th of December, 1880, the cutting of a new and shorter outfall channel, through the land, into Clayhole, in the estuary of the Wash, was commenced. The length of the new channel, from its commencement at Hobhole Sluice to its termination in the Wash, was three miles, and its sectional capacity was in excess of that of the Suez Canal or the Amsterdam Ship Canal. The depth of the excavation through the enclosed land was about 23ft.; and the strata consisted chiefly of silt and of brown and blue clay, with intersecting patches of peat, underlying which was a hard bed of boulder clay, in which the channel was formed for about two-thirds of its length. The material excavated was deposited in embankments on each side of the new channel, and a portion was utilised in forming the bank to close the whole channel. Outside the old sea bank the new embankments were extended simultaneously towards low-water mark on the outer foreshore, and then united in horseshoe fashion, so as to exclude the tides from as large an area of the works as practicable. By this means the middle and heaviest section of the excavation was executed in the dry; whilst the outer ends of the channel were completed by dredging. The total quantity of excavation was about 2,000,000 cubic yards, and the most suitable portion was selected for forming the exposed slopes. To effect the closing of the old channel, it was necessary to form an embankment, about half a mile in length, connecting the parishes of Fishtoft and Wyberton below Hobhole Sluice. The maximum height of this embankment was 35ft., with a minimum top width of 15ft., and side slopes of 5 to 1. The forming of this embankment was pushed forward simultaneously from the enclosed banks on each side of the old channel, and when the two opposite tip-heads had advanced within a distance of about 10 chains of meeting, two parallel groynes of fascine work and cliff stone were run out on each side of the old channel. These groynes afterwards formed the outer toe of the new embankment, across the fairway of the old channel. On the final closing of the old channel, a most difficult operation, owing to the tidal scour, the advantage of the new and shorter outfall to the estuary became at once obvious by the general depression in the low-water level. The incoming tides, instead of rushing up the river with a bore, as formerly, heavily charged with matter in suspension, now flowed in gently from the estuary comparatively clear, and vessels of 2,000 tons navigated the new channel with ease, compared with vessels of 300 tons, the largest the old channel could accommodate. In addition, the accumulation of deposit in dry seasons, during the absence of scour down the Witham, which formerly rendered neap tides insensible at the Grand Sluice, in Boston, was now practically nil. The area of land draining through the new channel was about 762,215 acres, but only 194,649 acres contributed to the cost of the works. The outfall between the new channel and the Grand Sluice had been improved generally by training works and dredging, and the channel was now 8ft. deeper than in 1878.

The enlarging of the Grand Sluice comprised the construction of a wider and deeper lock on the site of the old one. The new lock was 30ft. wide, or double the width of the old one, and the sills were 3ft. lower. The excavations were carried down to the hard clay, upon which was laid a bed of concrete 7ft. in thickness, consisting of 6 parts of ballast to 1 part of Portland cement. Upon this the floor was formed of finer concrete, and the sills of sandstone ashlar, 3ft. in thickness. The heel stones were of granite, and the side walls were formed of brickwork and concrete, faced throughout with blue Staffordshire bricks. The doors, or gates, six in number, were built of English oak. The outer pair, 24ft. 6in. in height, were self-acting, and closed, so as to prevent the tides flowing up the Witham. During floods all the doors of the Grand Sluice were thrown open, and the four openings now formed a waterway, 81ft. in width, for the free passage of the flood-waters to the sea.

The total quantity of the excavations in this section of the works was 602,059 cubic yards. The area draining through the Grand Sluice was about 500,000 acres, but only 34,726 acres, situated below Lincoln, contributed to the cost of enlarging the sluice and the improving of the river under the Act of 1881. The works were completed on the 21st of May, 1887, and they had, altogether, effected a material improvement in the drainage and navigation, and their aggregate cost was £212,000.

THE NORTHUMBERLAND COAL TRADE DISPUTE.—This dispute was amicably settled on Saturday last, when, at a conference between the coal owners and the miners, the latter agreed to accept an advance of wages of 5 per cent for hard coal, and 2½ per cent for soft coal.

ON THE INFLUENCE OF SILICON ON THE PROPERTIES OF TOOL STEEL.*

THIS paper records the results of a series of experiments upon the action of silicon upon tool steels of the highest class. The material operated upon was obtained from Dannemora iron containing copper 0·006 and phosphorus 0·015 per cent, with scarcely perceptible traces of sulphur, which was melted in crucibles with varying additions of a ferro-silicon containing 15 per cent of silicon. The limits within which the latter material can be used are comparatively narrow, owing to the circumstance that it has not been found possible to obtain any ferro-silicon with less than 0·2 per cent of phosphorus. In the first series of experiments steels of soft temper, suitable for wood-working tools, were produced having the following compositions :—

	C.	Si.	Mn.	P.
A ……………	0·783	0·342	0·37	..
A_1 ……………	0·826	0·840	0·43	..
B ……………	0·600	0·193	0·27	..
B_1 ……………	0·574	0·478	0·20	0·019

These were forged into flat bars, 45 by 6 millimetres, and converted into cutting tools for a wood-planing machine used for picture-frame mouldings. These tools, after cutting some miles' length of mouldings during a period of ten months, were reported to be equal in quality to those of the best English crucible steel, and no appreciable working difference could be perceived between them other than that A and A_1 were harder than the others.

Another series made with steels of harder temper, for metal-turning tools, was of the following composition :—

	C.	Si.	Mn.	P.
C ……………	1·050	0·229	0·41	0·015
C_1 ……………	1·075	0·675	0·52	0·023
D ……………	1·188	0·575	0·40	0·018
E ……………	1·091	0·690	0·37	0·019
F ……………	1·114	0·684	0·40	..
G ……………	0·941	0·377	0·36	0·028
H ……………	1·017	0·226	0·32	0·024

Of these, C to F were made of the best Dannemora material, while G, of a lower quality of Swedish iron, was prepared in order to test the influence of phosphorus when slightly in excess of the limit of 0·02 per cent. H represents the steel ordinarily used in the works which bears the mark of a famous Austrian steel manufacturer. The trials, continued over a period of fifteen months, showed all the experimental bars to be of first-class quality, the highest position being taken by D, which is closely followed by E, the latter being somewhat softer than the former. These are said to surpass all former steels in durability, tools made from them and used in cutting sharp-threaded screws keeping their edge five times longer than those previously employed. C and C_1 are somewhat lower in quality, and for similar treatment C appears to be more brittle than C_1. The somewhat high proportion of phosphorus in G does not appear to affect its quality.

By mistake a bar of the softer quality B was made into a turning tool and used for boring out a steam cylinder. This was found to be equal in working properties to C and C_1, the tool remaining perfectly sharp after eighteen hours' work.

No difference in working properties was observed, either in tilting the ingots or forging the tools, between the samples poorer or richer in silicon, but the fractures differ very considerably in appearance, the latter giving an uneven surface with projecting ridges, and forming the so-called lines of fracture of Martens.

From these experiments the author concludes that silicon up to 0·8 per cent has no injurious influence upon tool steel, and that with 0·5 or 0·6 per cent it improves the quality. He is now engaged upon experiments with steel containing 1 per cent of silicon, made without the use of a silicite containing phosphorus.

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* Foreign Abstracts Proc. Inst. C.E.

SETTING OUT JOY'S VALVE GEAR.

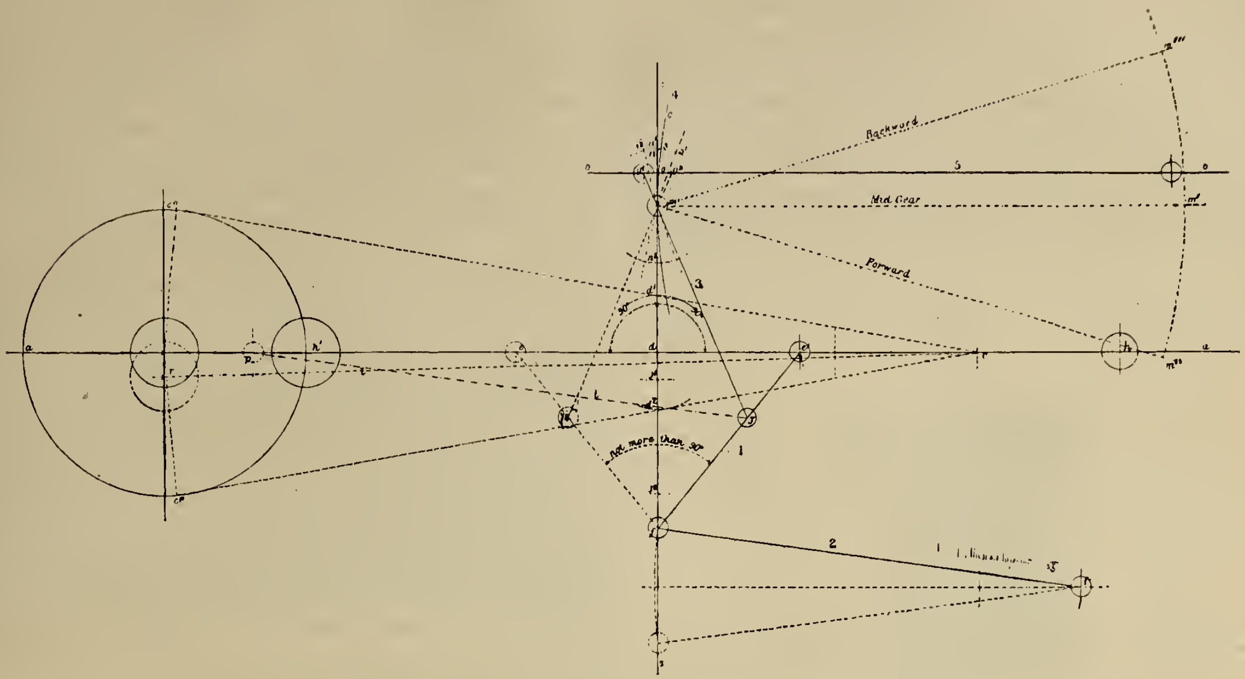
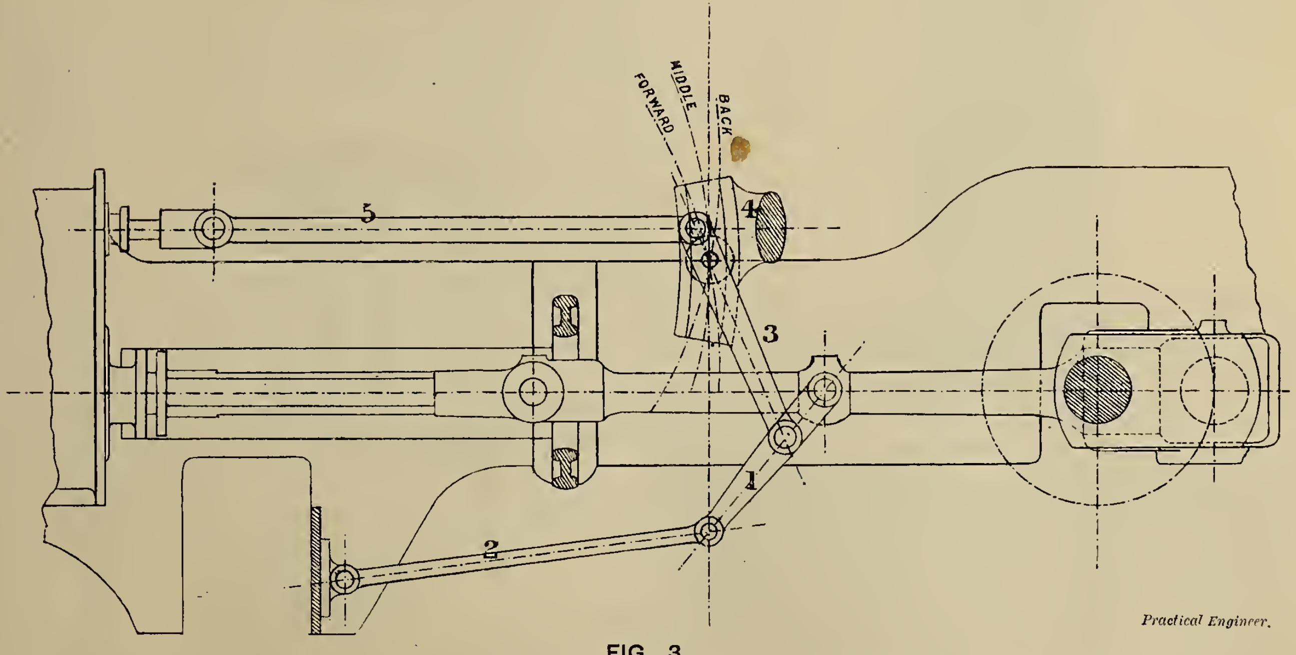


FIG. I.



Practical Engineer.

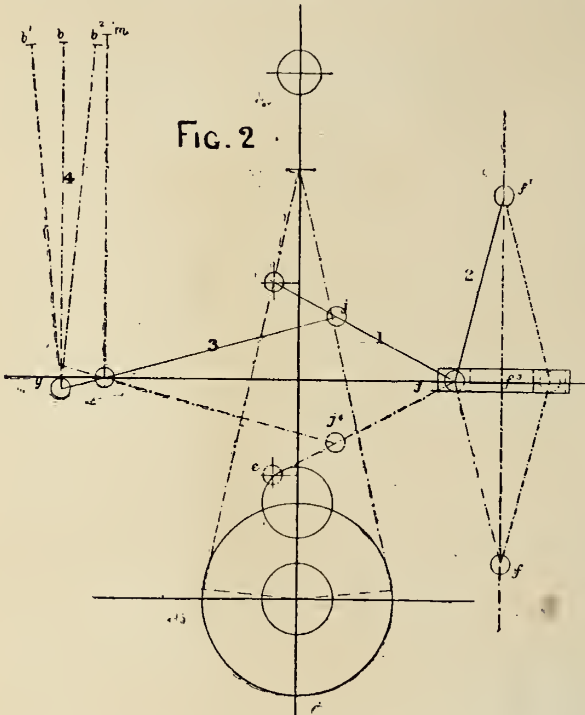
FIG. 3.

We have had several inquiries addressed to us with reference to the setting out of Joy's valve gear, and as many of our readers do not appear to be very familiar with the arrangement, we have thought it would be of interest if we gave at length the rules for setting out the centre lines of the arrangement which have been drawn up by Mr. David Joy, the inventor of this patent valve gear, and which he has kindly supplied us. Mr. Joy's instructions are as follow:—

Lay down the centre line of the cylinder a a, and that of the valve spindle b b, at the relative distances required for the engine to which the application is to be made, the valve spindle centre line being, however, in the plane of the vibration of the connecting rod. Draw the path of the crank pin, and the centre lines of the connecting rod c c^1 c c^{11} for both upper and lower positions when the piston is at half-stroke. Take a point d on the centre line of the connecting rod, where its vibration between d^1 and d^2 is equal to about double the length of the full stroke of the valve (it is better to allow rather more than less). It may, however, be chosen very much to suit the other arrangements of the engine, such as the position of the slide bar brackets, &c., getting, however, if possible, a vibration of the connecting rod fully equal to double the stroke of the valve, to avoid too great an angle of the slide link when angled for full forward or backward gear.

Having chosen the point d, draw a vertical line z z through it and at right angles to a a, and mark off the two points e, e^1 on each side, these being the extreme positions of the point d on the connecting rod for front and back stroke; from these points draw lines to a point f on the vertical, so far down that the angle between them shall not be more than 90 deg.; less is better, if there is room to allow of it (these will represent the centre lines of the first connecting link pinned to the connecting rod marked 1 in figs. 1, 2, and 3). The point f, which will rise and fall with the vibration of the connecting rod, is to be controlled as nearly as may be on the vertical line by a link pinned either forward near the cylinder at f^1, or if more convenient it can be pinned backward. This link, which is called the anchor link, is marked 2 in the same figures, or the point f may run in a slide (see f, fig. 2). Next, on the valve spindle centre line b b, mark off on each side of the vertical z z the amount required for lap and lead together, as g-g^1 and g-g^2; g-g^1 being "lap and lead" for the front end of the cylinder; and g-g^2 being "lap" and "lead" for the back end of the cylinder. Then, assuming the piston to be at the front of the cylinder, and the centres of the connecting rod to be at h h^1 (h^1 being the crank pin), the point d, which we have chosen to take motion from, will be at e^1, and the link pinned to the connecting rod for transmitting motion to the valve will be at e^1 f. From a point on this link, which has at first to be assumed, say at j (which will be about one-third more than the half vibration of the connecting rod, that is d to d^1), draw the centre line of the lever 3 (see also figs. 2 and 3), actuating the valve, that is joining j and g^1; the point where this line crosses the vertical z z will be the centre or fulcrum of the lever, and will also be the centre of oscillation of the curved links 4, in which the blocks carrying the centre of the lever slide; this centre is marked m, and stands for both centres, which must be concentric at each end of the stroke. The function of the link $e^1 = f$, and the attachment of the valve lever to it at j, is to eliminate the error in vibration of the lever centre m, which would otherwise arise, from the arc passed through by the lower end of that lever. Although the position of the point j may be found by calculation, it is much more quickly found by a tentative process; and to test if the assumed point j be the correct one, we mark off on each side of m, vertically, the correct equal vibration required, n^1 n^2, which will be the same as the vibration of the connecting rod on the vertical line, z z. Then apply the distance e^1—j to d^1—j^1 and d^2 j^2. Then, if the length j m be applied to j^1 n^1 (measuring from j^1) and to j^2 n^2 (measuring from j^2), and the point m fall below n^1 n^2 in each case, it will be necessary to take a point on e^1 f higher than j; or if, on the other hand, m falls above n^1 n^2, then a point must be taken on e^1 f lower than j. This point will generally be found on a second trial, but the length j, m of the lever j, m, g^1 must be such that its centre m vibrates equally on each side of the centre of the quadrant, also marked m.

FIG. 2



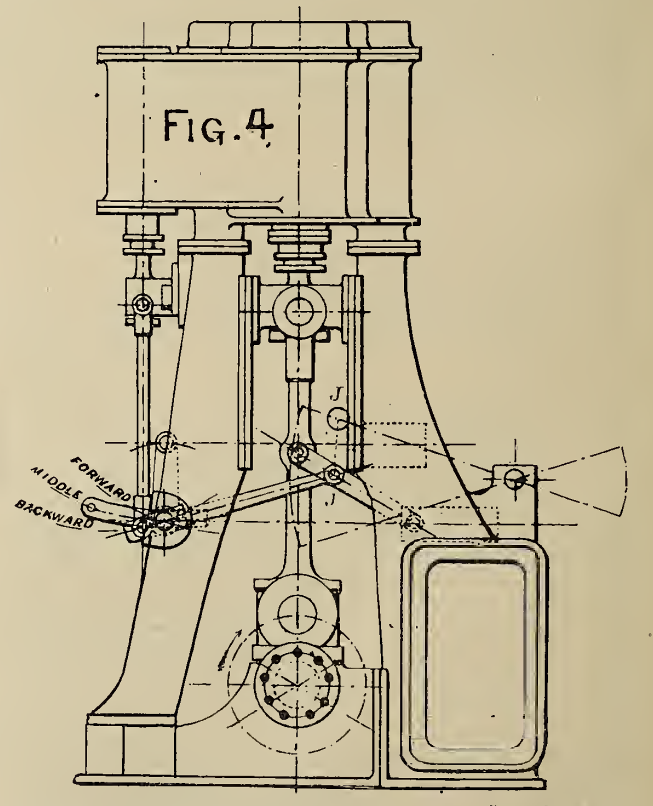
Practical Engineer.

The point m, as said, now represents the centre of oscillation for the links 4 and the centre or fulcrum of the lever 3. And these, as already said, must coincide when the piston is at each end of the stroke, the lead being then fixed, and the links can be pulled over from forward to backward or any point of expansion without altering the lead. This may be taken as a test of the gear being set out correctly.

The point g will be the point of attachment for the valve spindle link marked 5 (see also figs. 3 and 4), which may be made any convenient length, but from that length as a radius the curve of the links must be drawn from a centre m^1 on the parallel line m—m^1; the angle at which this curve is set from the vertical (which is mid-gear) will give forward or backward gear—the angle leaning forward s^1, or to the front of the engine, being forward gear, and the reverse s^2 being backward gear. The centres for these curves will be found at m'' and m'''. The amount of the angle, marked on the curve of extreme vibration at s-s^1 or s-s^2, will be equal to one-quarter more than the full opening of the port at that angle (that if 1″ opening of port be required, then the amount of the angle s s^1 must be $1\frac{1}{4}''$), and the point of cut-off will be about 75 per cent. Laid out in this form the "leads" and "cut-offs" for both ends of the cylinder, and for backward and forward going, will be practically perfect and equal, and the opening of ports also as near as possible equal. If a longer "cut-off" than 75 per cent is required, it is only necessary to increase the angle of the curve o o beyond s^1 for forward gear, or beyond s^2 for backward gear. It will be noticed that in this gear the "lap" and "lead" are entirely dependent on the action of the lever, j, m, g^1, as a lever, and may be varied according to the length of m g^1. And the opening of the port (beyond the amount given as lead) is dependent on the amount of angle imparted to the curved link o o, and will be as above said, about four-fifths of the amount of that angle from the vertical, measured on the line of extreme vibration. Instead, however, of employing a curved link with slide blocks to guide the centre or fulcrum of the lever 3, this centre may be hung in sling links, having their centres of suspension adjustable in the curve m' m'' m''', such centres of suspension representing the points for "mid-gear," "backward," and "forward" going. All the rules for laying out the gear will, however, remain the same.

Deviations from the above positions and proportions may be made without materially altering the correctness of the results.

FIG. 4



Practical Engineer.

Thus, if it is found necessary to raise or lower the centre m, to clear wheels, frames, or other gear, without altering the position of the valve spindle centre, this may be done till the angle of m m^1 is out of the parallel of the cylinder centre line, up or down, by one in thirteen (1 in 13); it is not well to go beyond this, but the lines m m^1 and b b will be parallel, and the position of the curve o o for mid-gear will be at right angles to m m^1.

Again, the point e^1 may be taken either above or below the centre line of the connecting rod, if it be wished to avoid piercing the rod, the pin at e^1 being carried in a small bush or block attached above or below the connecting rod, or to a boss forged on the connecting rod.

Again, for locomotives, if the wheels are so small that the link e^1 f would come too low, it may be cut short at the point j, and this point connected by a link l l to a small return crank p, on the crank pin, the movement of the counter-crank being equal to that from j to j^4.

The diagram is drawn for an engine where the centre of the crank axle is on the centre line of the cylinder, but if this be below, as is usual in American locomotives, then the base line on which to construct the diagram of the valve gear itself will be the average centre line assumed by the connecting rod for such lowering of the crank axle centre, drawn from c, the middle position to a point, say r, representing the lowered centre of the axle. The vertical $z\,z$ will be at right angles to this new base line $c\,r$, all the other processes following.

For vertical engines the same rules apply, by placing the diagram vertically and altering relatively the terms "vertical" and "horizontal."

While the proportions shown on the diagram give the best average results, these proportions may be varied within very wide limits, according to the requirements of the design of the engine. Thus, when the distance between the centre of the cylinder and centre of valve spindle is small, as with a small cylinder and a long stroke, the link $e^1\,f$ may be considerably lengthened; the point j will thus be dropped, and convenient angles for all the links, &c., will be maintained, the room for the various movements being got below the centre line of the cylinder when it cannot be had above.

In marine engines the reverse conditions are usual, the distance between the cylinder and valve spindle centres being abundant, and very little room available behind the engine. In this case the point e^1 may be taken out of the centre line of the connecting rod (see fig. 2), so bringing all the gear so much further forward.

The end of the link 1 may then be swung at f by the link 2 centred either above, as at f^1, or below, as at f^2, or it may be carried in a cross slide, f^3.

Also to accommodate the centre lines of the valve spindles of the high and low pressure cylinders (if different), one centre may be carried outwards to b^1 and the other inwards to b^2, from the normal centre line b; this angle may be as much as 1 in 12 without affecting the accuracy of the gear. The centre line of the quadrant at mid-gear will, however, be always at right angles to the altered vertical centre line. In all cases it is well to keep the levers and links as long and the angles as easy as the room at disposal will allow.

THE "COMPACTUM" FEED-WATER HEATER.

One of the most troublesome difficulties experienced in connection with the working of marine boilers arises from the unequal expansion between the upper and lower portions of the shell in consequence of the difference of temperature between the water and the steam. This difference is, of course, most manifest when the fires are being got under way in the first instance, but the constant influx of fresh feed supply when the boiler is at work causes it to be always in existence to a greater or lesser extent, and the evils arising from the presence of "dead" or stagnant water at the bottom of marine boilers are too forcibly thrust upon the notice of marine engineers to require dilating upon. Not only is the circulation seriously impaired, and the economy of the boiler as a steam generator thereby injuriously affected, but the racking stresses brought into play by the difference of temperature give rise to serious leakage at the seams of rivets at the bottom of the shell, which soon necessitates extensive repairs, and materially shortens the life of the boiler.

With the enormous increase of pressures that has taken place of late years, the evils arising from the difficulty to which we have referred have become accentuated, while the more costly character of the structures that are now laid down renders it more than ever desirable, for financial reasons, that their lives shall be prolonged as far as possible. To add a few years to the life of a boiler represents a money saving which only those who are called upon to effect its renewal can adequately appreciate. One of the most potent causes of decay in marine boilers, in addition to those enumerated, is the wasting from internal corrosion. Although many factors doubtless contribute to produce internal wasting, yet there can be little question that the rapid decay to which marine boilers are liable from this cause as compared with those on land is due in a large measure to the galvanic action which is set up by the salt water, and which is accelerated by the difference of temperature between the various parts of the shell.

It will be evident, from what has been said, that the maintenance of an even and constant temperature in a marine boiler is an object to be sought on every ground, and to the capacity displayed by Mr. John Kirkaldy, of 40, West India Dock Road, London, in grasping this fact and carrying it into practice in the design of his "Compactum" feed-water heaters, must doubtless be attributed the great success that has attended their working. The heater, as will be seen on a reference to the accompanying illustration (fig. 2), consists of a series of coiled corrugated tubes contained within a cylindrical vessel. Through these tubes a current of live steam is admitted direct from the boilers, while the feed supply from the pumps flows in an opposite direction through the cylindrical vessel surrounding them, and thereby attains a temperature almost equal to that in the boiler before its introduction.

To contend that such an arrangement can possibly result in economy, no doubt appears preposterous at first sight, and quite opposed to all ordinary conceptions regarding the laws of heat, and to claim any such advantage would require a considerable amount of moral courage on the part of the inventor in the first instance. But paradoxical as such a statement may appear, there can be no doubt that it is true. The "proof of the pudding is in the eating," and the independent testimony afforded by the superintendent engineers of leading shipowners throughout the world, after several years' experience and practical trials, affords indisputable evidence on this score.

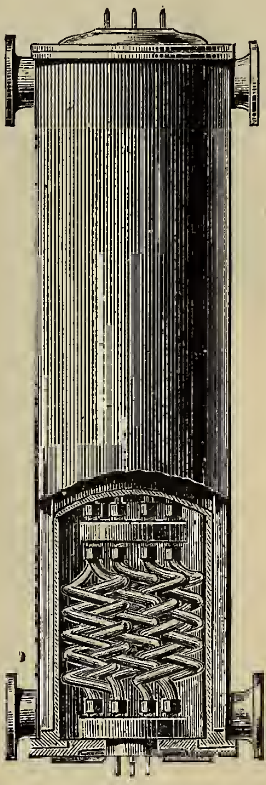


Fig. 3.

That the raising of the temperature of the feed water so as to approximate more closely to that of the steam will be productive of beneficial and economical results, in consequence of the saving in repairs and increased longevity of the boiler, will, we think, be apparent after what has been said, and if a little consideration be given to the matter, the immediate saving which is found to be effected in the coal bill by heating the feed water with live steam, is not so paradoxical after all, for one result of the introduction of hotter feed will be an improvement in the circulation of the water in the boiler, and, consequently, an increase in the efficiency of the heating surface.

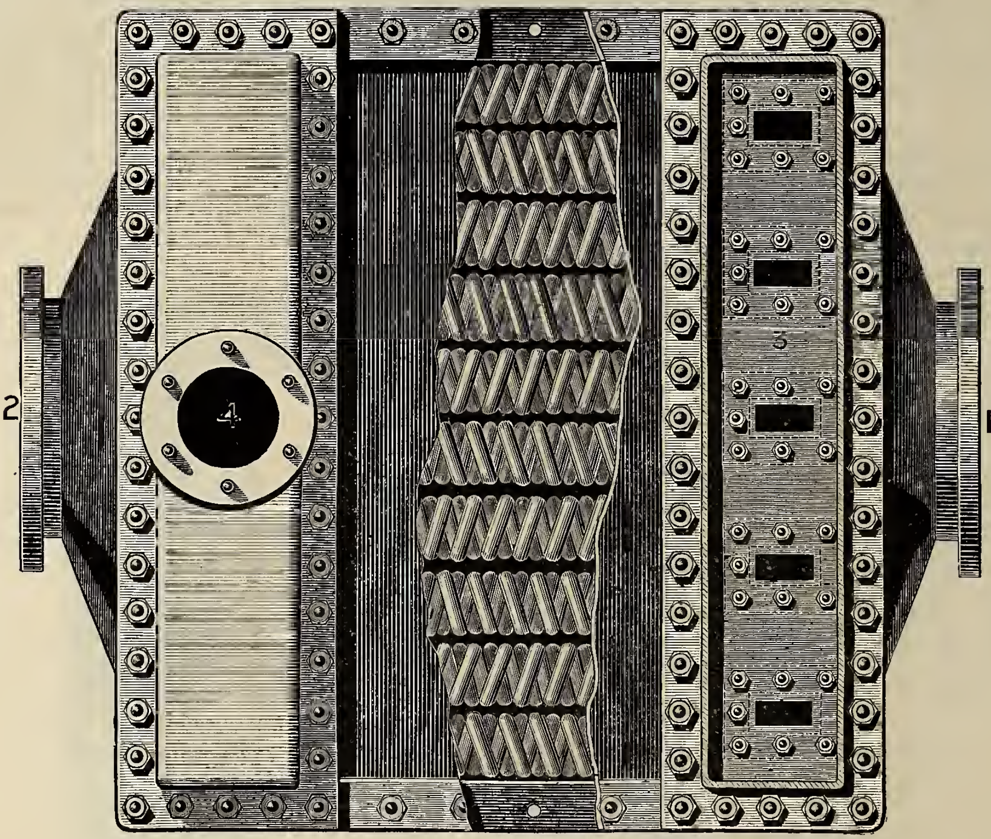
A careful examination of the evidence furnished by the numerous testimonials received by Mr. Kirkaldy bearing on this point, would seem to show that the economy effected by the adoption of the heater is largely due to this fact, enabling, as it does, the same boiler to generate steam more rapidly without urging the fires to the same extent, and thereby permitting a more economical combustion of the fuel. But whether this be or be not the correct explanation of the economy effected, the evidence with regard to the economy itself is such as cannot be gainsaid.

On page 596 we illustrate one of Mr. Kirkaldy's heaters, which was erected at the works of the Barrow Hematite Steel Company. The heater was one of the largest that have been erected, and was designed for heating the feed-water for sixteen large Lancashire boilers, 8ft. in diam., by means of exhaust steam, the diameter of the exhaust steam inlet being 16in., and the feed inlet 6in. The feed supply was drawn cold from the town's mains, and with ten to twelve boilers at work the temperature of the feed varied from 195° to 200°, thus effecting a saving of 10 to 11 per cent.

THE "COMPACTUM" FEED-WATER HEATER.

CONSTRUCTED BY MESSRS. JOHN KIRKALDY, WEST INDIA DOCK ROAD, LONDON.

(For description see page 597.)



IMPROVED HEXAGON NUT-SHAPING MACHINE.

We illustrate, on page 599, a very compact machine which has been specially designed by Messrs. James Spencer and Co., Chamber Ironworks, Hollinwood, Manchester, for shaping hexagon nuts.

The machine is fitted with two tables measuring 18½in. by 12in., while each table carries two dividing headstocks, each of which is in turn fitted with mandrels for holding the nuts which are required to be shaped. The ram is furnished with two tool boxes at each end, while each box is fitted with three shaping tools. These tools are each capable of independent adjustment, and are so arranged as to cut at one end on the forward stroke and at the opposite end on the return stroke. The tables are self-acting in the horizontal direction, and are fitted with an independent reversible feed motion, so as to insure the cut being put on at the commencement of the stroke in every case. The machine, which is capable of shaping all sizes of nuts up to 1in. in diameter, is driven by a large belt pulley in preference to gearing, in order to secure a better finish on the face of the nuts. The machine, as will be apparent from the engraving, is strongly made, and is finished throughout in Messrs. Spencer's usual first-class style. The general finish and excellence of castings composing the framework not only of this, but of all other machines to which Messrs. Spencer and Co. devote their attention, call for a special word of praise.

Great Lock-out at Barrow.—On Monday morning, the men employed at the blast furnaces at Barrow left work in a body, their notice for an advance of wages having expired. Eleven furnaces are standing idle. The Steel Company have in consequence closed both the iron and steel works, over three thousand men being thus locked out. It is not expected that the dispute will be of long duration.

EXPERIMENTAL TESTING OF MESSRS. J. BROWN AND CO.'S RIBBED AND GROOVED FURNACE TUBES.

(Continued from page 583.)

The ultimate permanent sets found in the tubes at the points previously gauged for deformation are as follow :—

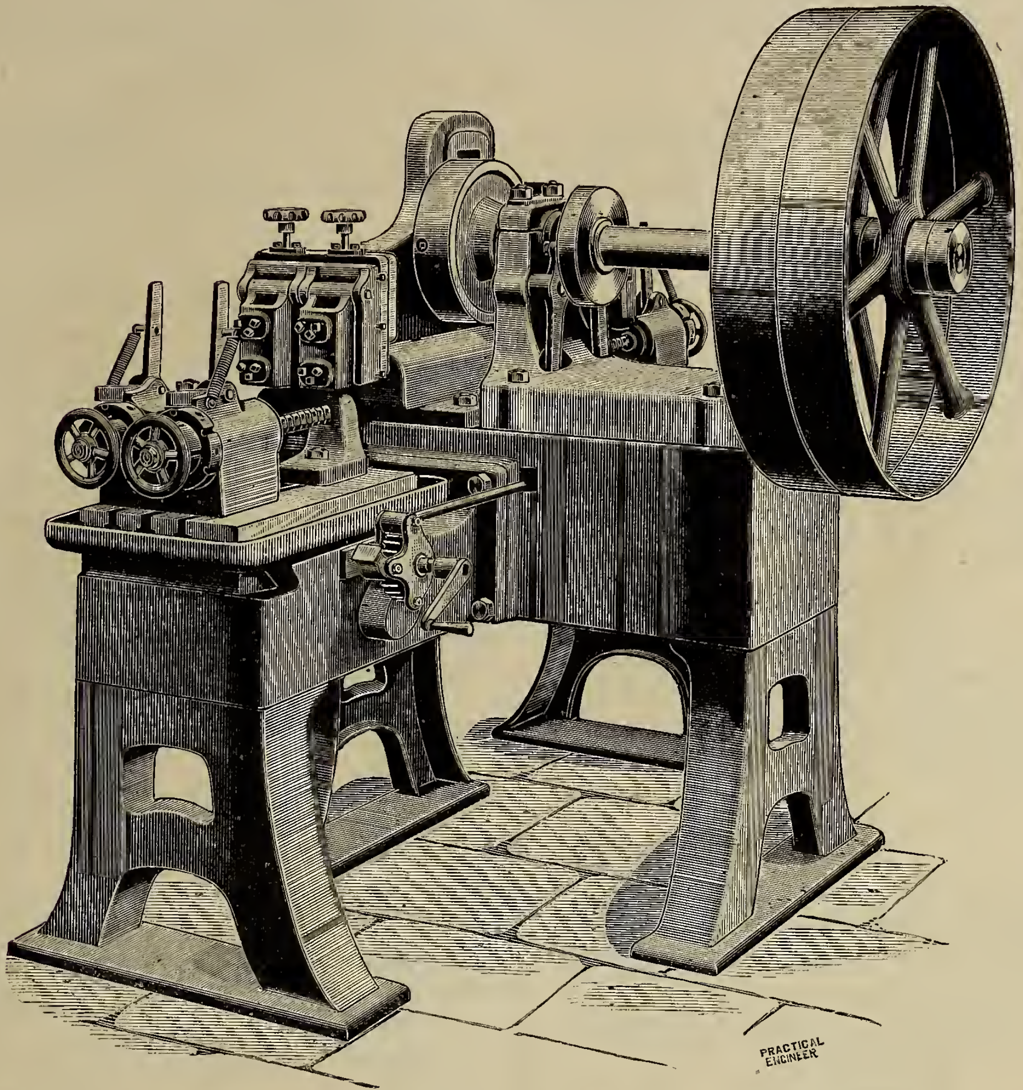
Distinguishing Mark on Tube.	Measurements taken at A.				Measurements taken at B.				Measurements taken at C.				Length of Tube increased.
	Vertically.		Horizontally.		Vertically		Horizontally.		Vertically		Horizontally.		
	Set.		Set.		Set.		Set.		Set.		Set.		Set.
	Inch.	In or out	Inch.	In or out.	Inch.	In or out.	Inch.	In or out.	Inch.	In or out.	Inch.	In or out.	Inch.
L	$\frac{9}{32}$	In	$\frac{20}{32}$	In	$\frac{7}{32}$ full	In	$\frac{6}{32}$ full	In	Nil.	—	$\frac{1}{32}$	In	$\frac{1}{32}$
K	$\frac{1}{32}$ bare.	In	$\frac{4}{32}$	In	$\frac{12}{32}$ bare	In	$\frac{11}{32}$ bare	In	$\frac{1}{32}$	In	$\frac{1}{32}$ full	In	$\frac{1}{32}$
J	$\frac{2}{32}$ full.	In	$\frac{2}{32}$	Out	$\frac{3}{32}$ full	In	$\frac{9}{32}$	Out	$\frac{1}{32}$	In	$\frac{2}{32}$	Out	$\frac{3}{32}$
I	$\frac{1}{32}$	In	$\frac{3}{32}$	Out	$\frac{5}{32}$	In	$\frac{12}{32}$ full	Out	$\frac{2}{32}$ bare	In	$\frac{3}{32}$	Out	$\frac{1}{32}$
H	$\frac{1}{32}$ bare	Out	$\frac{5}{32}$ bare	In	$\frac{20}{32}$	Out	$\frac{7}{32}$	In	$\frac{6}{32}$	Out	$\frac{3}{32}$ full	In	Nil
	$\frac{1}{32}$ bare	Out	$\frac{2}{32}$	Out	$\frac{5}{32}$	Out	$\frac{6}{32}$	Out	$\frac{1}{32}$ bare	Out	$\frac{1}{32}$ bare	Out	$\frac{3}{32}$

On the completion of each test I had the tube drilled in 12 places to ascertain its thickness.

IMPROVED HEXAGON NUT-SHAPING MACHINE.

CONSTRUCTED BY MESSRS. JAMES SPENCER AND CO., HOLLINWOOD, MANCHESTER.

(For description see page 598.)



The thickness of each pair of tubes was intended to have been ·312in. ($\frac{5}{16}$in.), ·437in. ($\frac{7}{16}$in.), and ·562in. ($\frac{9}{16}$in.) respectively, whereas the actual mean thickness was ·303in., ·533in., and ·612in. respectively. The mean thickness of the $\frac{5}{16}$in. tubes is thus seen to have been ·009in. less, and the $\frac{7}{16}$in. and $\frac{9}{16}$in. tubes ·096in. and ·050in. greater respectively than the nominal thickness. It will also be seen by reference to the tables that the mean thickness of the welded part of each tube was less, and in some cases considerably less, than the mean thickness of the unwelded part.

Deductions from Tests.

The ultimate compressive stress to which each tube was subjected was found by the formula :—

$$\frac{P \times D}{2\,T} = S \qquad (1)$$

where P = the pressure in lbs. per square inch on the tube when collapse occurred ;
D = the outside diameter of the plain parts of the tube in inches ;
T = the thickness of the plain parts of the tube in inches ;
S = the compressive stress in lbs. per square inch of section;
and the results are given in Table No. 3.

It will be obvious from the explanation of the above symbols, that the stresses were calculated on the hypothesis that each tube was of uniform section, and had a thickness equal to that of the plain parts between the ribs ; on this basis, no allowance is made for the enlarged section at the ribs, hence the stresses in the table are greater than those actually borne by the material.

Table No. 3.

Distinguishing letter on Tube.	Mean thickness of Tube.	Pressure per square inch at which Tube collapsed.	Comparative stress per square inch of the assumed section of Tube when collapse occurred.
		lbs.	lbs. tons.
L	·295	600	39,291·84 = 17·54
K	·311	635	39,444·53 = 17·61
J	·508	800	30,671·65 = 13·69
I	·558	800	27,883·15 = 12·44
H	·611	875	27,883·28 = 12·44
M	·613	873	27,664·70 = 12·35

The marked increase in the ultimate compressive stresses of the $\frac{5}{16}$in. tubes, as given in the preceding table, was obviously due to the superior stiffening effect of their ribs, which, although similar in form to those of the other tubes, were of much greater sectional area in proportion to the sectional area of the plain parts.

The elastic compressive stresses of the plates from which the tubes were made were given in the appendix, from which it appears the annealed plates vary from 14·0 tons to 15·4 tons per square inch of section. These stresses cannot, for the reason given, be satisfactorily compared with those in the preceding table, but they may be usefully compared with the stresses per square inch of *gross* section borne by the tubes. These two sets of stresses are placed side by side for comparison in the following table, No. 4, where it will be seen from the column containing the differences that in each case the elastic compressive strcss of the plate is considerably in excess of the stress in the tube when collapse occurred.

TABLE NO. 4.

Distinguishing letter on Tube.	Mean thickness of Tube.	Compressive stress per square inch of gross section of Tube when collapse occurred.	Elastic compressive stress per square inch of plate section as given in the Appendix.	Elastic compressive stress of plate greater than compressive strcss in Tube when collapse occurred.
	Inch.	lbs. tons.	lbs. tons.	lbs. tons.
L	·295	26,783 = 11 95	31,400 = 14·0	4,617 = 2·06
K	·311	27,334 = 12·20	32,200 = 14·4	4,866 = 2·17
J	·508	24,127 = 10·77	34,300 = 15·3	10,173 = 4·54
I	·558	22,361 = 9·89	34,500 = 15·4	12,139 = 5·41
H	611	22,752 = 10·15	32,133 = 14·3	9,881 = 4·18
M	·613	22,587 = 10·08	32,100 = 14 3	9,518 = 4·24

The constant in the board's formula for computing the working pressure for short plain tubes equals the ultimate compressive stress divided by one half the factor of safety, and is usually found by the formula :—

$$\frac{D \times P}{T \times F} = C \qquad (2)$$

where C and F are the constant and factor of safety respectively, and D, P, and T have the same signification as in equation (1).

The constants suitable for the tubes under consideration have been computed in the above manner, F being taken as 5·2, and they are given in the following table, No. 5. This table also contains the mean constants for the four thickest, as well as the mean constant for each pair of tubes.

TABLE NO. 5.

Distinguishing letter of Tube.	Mean thickness of Tube.	Constant as found from the result of the experiments.	Mean constant for each pair of Tubes.	Mean constant for the four thickest Tubes.
	Inch.			
L	·295	15112	15141	
K	·311	15171		
J	·508	11796	11260	10971
I	·558	10724		
H	·611	10724	10682	
M	·613	10640		

These so-called constants are proportional to the nominal compressive stresses given in Table No. 3, and, like them, are directly affected by the relation existing between the section of the ribs and the total section of the tubes.

The $\frac{7}{16}$in. and $\frac{9}{16}$in. tubes fairly represent furnace tubes of modern marine boilers, as regards thickness, hence the mean constant (in round numbers) for these tubes, viz., 11,000, might fairly be taken as the constant for the board's formula

$$\frac{C \times T}{D} = \text{W.P.} \qquad (3)$$

where C and W.P. are the constant and working pressure respectively, and T and D signify the thickness and diameter of the tube, as in equation (1).

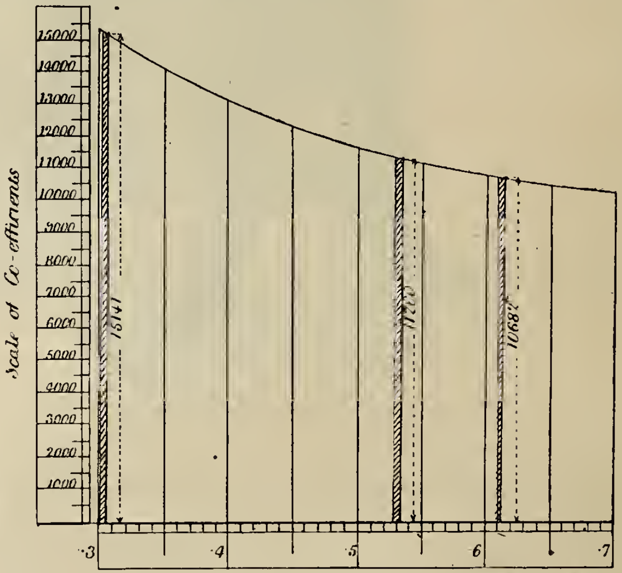
This formula, with a constant multiplier (C), appears suitable for the range of thickness that now obtains; but if a variable coefficient be considered more desirable than a constant, the coefficient for any thickness of tube between ·3in. and ·7in. may be readily found by inspection, or measurement, from the diagram (fig. 4) which I have designated a curve of co-efficients. The ordinates to the curve are the co-efficients, drawn to a scale of one inch per 1,000, and the abscissa represents the thickness of the tube magnified ten times. The ordinates represented by section lines are those found from the experiments. This curve graphically and forcibly illustrates the diminution in the resistance of these tubes as the thickness is increased, and it will be observed that when the latter amounts to ·7in. the co-efficient is 10,000, which is only about 66 per cent of the co-efficient for the thinnest tubes.

If the working pressures for the experimental tubes be calculated by equation (5), they will be found as stated in Table No. 6, which also contains the working pressures for the four thickest tubes, when C for each of these tubes is considered equal to 11,000.

TABLE NO. 6.

Distinguishing letter on Tube.	Mean thickness of Tube.	Maximum diameter (outside) of tube at mid-length.	Working pressure by formula $\frac{C \times T}{D} = \text{W.P.}$ when C is taken from Table No. 5.	Working pressure by formula $\frac{C \times T}{D} = \text{W.P.}$ when C = 11,000.
	Inch.	Inches.	Lbs.	Lbs.
L	·295	38·637	115·3	—
K	·311	38 637	122·1	—
J	·508	38·953	153·8	143·4
I	·558	38·897	153·8	157·8
H	·611	38·941	168·2	172·5
M	·613	38·851	167 8	173·5

It will be observed that in three cases out of four the working pressure, as found by the proposed formula, is in excess of what should strictly be allowed; but, if the form of the experimental tubes had been as good as that of tubes made for use in boilers, their resistance to collapse would doubtless have been increased sufficiently to make up the difference.



Practical Engineer.

FIG. 4. Thickness of Plate magnified ten times.

The mean constant (11,000) for the four thickest tubes is somewhat greater than that found for the four tubes of equal nominal thickness in the first experimental series, but it is still far short of the constant for Fox's corrugated tubes, viz., 12,500, and I see no ready means of augmenting it, except by increasing the number or height of the ribs, and improving the form of the tubes by passing them through bending rolls. If the latter suggestion were adopted, the tubes would require to be hot during the rolling, otherwise the welded parts of the ribs would probably be cracked by the bending action of the rolls. In this connection it should be mentioned that the height of the ribs of the plates from which all the tubes were made was about $1\frac{3}{8}$in., whereas their height in the four thickest tubes was only about $1\frac{5}{16}$in., thus showing that the ribs had been stretched very materially in the process of bending the plates into the cylindrical form. This result is what might naturally have been expected, for an examination of the sections, fig. 3, shows that the quantity of metal above the outer surface of the tubes is comparatively small, and the neutral axis of the section, or the axis around which the plate may be assumed to turn, while being bent into the cylindrical form, consequently low. The distance from the neutral axis to the top of the ribs is, in the three sets of tubes under consideration, about 1·16in., 1·32in., and 1·35in. respectively; hence in the latter case (the thickest tubes) the permanent extension of those portions of the ribs farthest removed from the neutral axis must have been about

$$2 \times 1{\cdot}35 \times 3{\cdot}1416 = 8{\cdot}48\text{in.}$$

This extension would, assuming the material to have been homogeneous and of uniform thickness, be equally distributed over the circumference of the tube, which, at the neutral axis, was about 122in. The stress corresponding to an extension of, say, 8½in. in this length, is about 49,000lb. per square inch, in material having an ultimate tensile strength of about 57,500lb. per square inch. This stress is about 86 per cent of the ultimate strength of the plate. The latter stress appears from the tests made to have been about 62,700lb. per square inch; hence the former probably amounted to about

$$62{,}700 \times {\cdot}86 = 53{,}922\text{lb.}$$

A stress of this magnitude is very high, considering that want of homogeneity, as well as irregularity in the thickness of the plates, would tend to intensify it, and unless great care be taken in selecting suitable plates, I should not be surprised to hear of cases arising in which one or more of the ribs had actually cracked during the bending process.

The annealing process to which the tubes are finally subjected doubtless removes to a very great extent the stress set up in the ribs by cold bending, and, where it is efficiently done, the ductility must also be materially recuperated.

It will be seen from the foregoing, that the finished height of the ribs is affected by the thickness of the body of the plate and by the diameter of the tubes, but it may also be affected by the temperature of the plate while being rolled from the slab. Rolling a ribbed plate at a low temperature would probably harden its body without affecting the ribs to an equal degree, and, if this view be sound, it follows that the distance from the crown of the ribs to the axis around which the plate turns in bending would be increased, and the height of the ribs correspondingly reduced.

When the thickness of these tubes is regarded as infinitesimally small, the sectional area of each rib is found to be about 1·24 square inches; hence this quantity added to that represented by the mean thickness of the plate, and multiplied by the pitch of the ribs, is, on the hypothesis that all the ribs are alike, the actual sectional area between the centres of two ribs.

This formula may be expressed thus:—

$$(T \times 9) + 1{\cdot}24 = A \qquad (4)$$

where T represents the thickness of the tube, and A the actual sectional area between the centres of two ribs.

It will be obvious from the above equation that the *gross* sectional area of any one of the tubes under consideration is equal to that of an ordinary *plain* tube of the same length having a thickness equal to

$$T + {\cdot}137$$

and it need hardly be stated that when

$$T = {\cdot}137\text{in.}$$

the effect of the ribs on the sectional area and weight of the tube is to increase them 100 per cent, whereas when T equals ⅝in. (·625) the increase in these respects is reduced to about 22 per cent.

If the compressive stresses per square inch of gross section of the tubes had been uniform in amount, the formula

$$\frac{C \times (T + {\cdot}137)}{D} = \text{W.P.} \qquad (5)$$

would have been highly satisfactory (within certain limits) for computing the working pressure; but as these stresses are not quite constant (see column 3 of Table IV.), I have deemed it desirable in this report to give prominence to the formula in which the sectional area of the ribs is omitted. I may mention, however, that if the *mean* compressive stress per square inch of gross sectional area had been taken as the compressive value of any one of the six experimental tubes, the value of C in the above formula would have been 9,355, which is not much in excess of the constant (8,800) in the board's formula for short plain tubes made of steel.—I am, &c., PETER SAMSON.

The Engineer Surveyor-in-Chief, Board of Trade.

OBSERVATIONS OF THE ENGINEER SURVEYOR-IN-CHIEF.

The experiments have been most carefully made, and the results obtained are a valuable addition to our knowledge respecting these furnaces.

These furnaces are getting a fair share of patronage, and time alone can settle if they are to become more generally adopted than some of the others now successfully used. There are at least two things which will settle this point, price and continued efficiency.

With a view of giving every encouragement to high pressures, I think the constant of 11,000 may be used for all thicknesses: this is liberal for the present thicknesses and high pressures necessary, and at the same time is prudent, looking to defects and thinning that may develop after the furnaces have been in use.

The working pressure may be found by the following formula:

$$\frac{11{,}000\,T}{D} = \text{W.P.}$$

T = thickness in inches of plate in plain part; D = diameter in inches of furnaces outside, at plain part; W.P. = working pressure in pounds per square inch.

The ribs should not be less in height than 1⅝in. above the plain part, and the grooves not more than ¾in. deep.

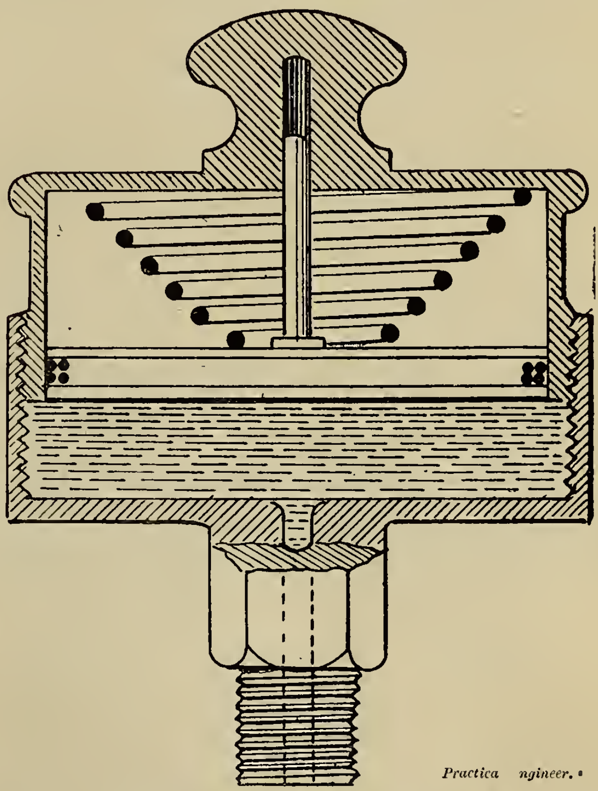
THOMAS W. TRAILL.

The Assistant Secretary,
Marine Department, Board of Trade.

THE KINGFISHER LUBRICATOR.

THE accompanying illustration shows a form of lubricator made by the Kingfisher Co., Leeds, which possesses one or two novel features that render it specially adapted for cases where it is desirable to use lubricants of a semi-solid character.

The construction of the lubricator will be readily seen from a reference to the accompanying illustration. The lower cup, which contains the lubricant, is fitted with a hollow screwed stopper having a piston which is pressed upon the surface of the lubricant by a spiral spring. On screwing down the upper cover the spiral spring becomes compressed, and thereby causes a constant pressure to be exerted by the plunger throughout the length of its stroke. By this means the lubricant is gradually forced out, and a constant and continuous supply fed to the bearing, thus securing more perfect and economical lubrication. The fitting can be fixed in any position, either above, or below, or on the side of horizontal or upright bearings.



EXPLOSIONS OF NAPHTHA GAS.—Two Russian chemists, Jawein and Lamansky, have been conducting experiments to determine the explosive properties of a mixture of naphtha gas and atmospheric air. Their experiments prove the mixture to be explosive when it consists of 1 volume of the gas and from 5·6 to 17·7 volumes of air—that is, when the mixture contains not less than 85 per cent of air and not more than 94·4 per cent. It takes less of the gas of naphtha, therefore, than of fire-damp to make an explosive mixture with air.

EXPERIMENTS ON THE STRENGTH OF WELDED WIRE ROPES AND WIRE.*

These tests were undertaken by order of the Minister of Public Works, and the material was supplied by Messrs. Felten and Guilleaume, of Mülheim, on the Rhine. In what follows the place in which a single wire is welded is called a weld, while an accumulation of several welds in the same section of a wire rope is designated a joint.

The wire rope samples, from which the test pieces were taken, were of various constructions, as follow :—

(*a*) A wire rope, in various pieces, consisting of six strands each of six wires with hemp core and hemp packing in the strands; steel wire 2·5 millimetres in diameter (0·1in.) and with a tensil strength of about 130 kilograms per square kilometre 82·5 tons per square inch).

(*b*) Two wire ropes and one strand of different construction: One rope with six joints at distances of 1 metre (3·28ft.), each strand containing a wire with a single weld ; the rope made up of six strands, each consisting of seven wires, one of which formed the core, the principal core of tarred hemp ; iron wire 3·2 millimetres (0·128in.) in diameter. A second rope with six joints at distances of 1 metre, each strand containing a wire with a single weld ; the rope constructed in the same way as the first, but with steel wire 2·5 millimetres (0·1in.) in diameter. One strand constructed of six wires 2·6 millimetres (0·102in.) in diameter, each with one weld distributed in six places 1 metre apart, and a seventh unwelded wire as core.

Besides these, several samples of wire of various sizes from previous experiments were tested unwelded and welded in different ways.

Ropes of the same construction but with various arrangements of the joints and welds were tried. In some cases ropes which had previously been tested were again experimented on with the same loads.

The following results were observed: In the case of a new rope, not previously loaded, every increase of stress produced a small permanent extension ; on repeating the tests this did not again occur, but the extensions were almost exactly proportional to the loads. When at the second test the load exceeded the maximum previously attained, a permanent set was observed.

In those test pieces in which the welds were distributed over a length of about 500 millimetres (say 20 inches), there was no appreciable diminution of the strength as compared with test pieces without welds, even when one-sixth of all the wires were welded in one section. In those ropes, however, in which the welds were all in one place, the strength was reduced by about 33 per cent. The extension of ropes having joints in every case proved to be less than that of ropes without joints, the extension of that with one joint being the least. The form of weld was found to have a considerable influence on the strength of the wire—generally the longer the weld the greater the strength. For the purpose of manufacturing wire rope, it is not merely the strength of the weld that is of importance, but also that the latter should be of such a character as to insure the maximum flexibility of the wire. The results of the tests are given in the original in a series of tables, and illustrated by diagrams.

CORROSION AND INCRUSTATION OF BOILERS.

In continuation of a course of lectures on technical chemistry at the Owens College, Dr. Bailey treated, on Wednesday, the 28th ult., the subject of boilers from the point of view of the chemist and works manager.

Such a subject, he said, might also be looked at from the engineer's point of view with equal profit, and it is one of those well adapted to show the desirability of the chemist being in touch with problems which have till now been left too much in the hands of the engineer alone. After briefly alluding to the various types of boilers, the production of high-pressure steam was referred to, and the conditions under which superheated steam might be advantageously employed.

Much waste heat, he said, might be economised by the heating of the feed-water, and in this way not only might a very considerable saving of fuel be effected, but the life of the boiler would assuredly be prolonged, since the strains arising from sudden changes of temperature in the water would be reduced to a minimum by the use of heated feed-water.

With regard to the corrosion and the incrustation to which boilers are subject, the principal safeguards consisted in a knowledge of the character of the water used for the boilers, and no general nostrum for the elimination of these evils should be adopted without a knowledge of the class of water that was being dealt with.

The method of examining feed-water and the particulars towards which attention should be paid were described. The more objectionable and common impurities in water were, as is well-known, calcium carbonate, calcium sulphate, and especially salts of magnesium, but in addition to these the introduction of even small quantities of oil or grease, such as might arise where the feed-water is directly heated by exhaust steam from the cylinders, might act in a very deleterious manner and bring about serious corrosion. Even a soft water, if it contained organic matter, might in a similar manner be quite as injurious to the boiler as a hard water, since it had been shown that in this case, under certain conditions, free acid was formed. It was possible, indeed, in some cases with great advantage to use hard and soft waters alternately—the one acting as solvent on the incrustation caused by the other.

ON A NEW SYSTEM OF SHIPBUILDING*

Although competition and the increasing dimensions of ships have compelled shipbuilders to adopt heavier and improved plant in their yards, no very advanced changes have taken place in the methods of preparing and combining the material, but in the main points the old traditional system that developed out of wood shipbuilding is still in vogue.

The necessity of improvements in the art of shipbuilding has been felt ever since the introduction of iron and steel, and papers suggesting new systems of constructing vessels have from time to time been read before other societies.

The disposition of the material and the mode of combining the various parts of a ship's structure, in order to obtain the greatest amount of strength and economy of workmanship, can never be too well considered ; and as no paper treating on this important question, from either a practical or theoretical point of view, has yet been read before this institution, the writer ventures to entertain a hope that this paper will at least lead to an instructive discussion, and cause the members to give their opinions on how improvements should best be effected.

Labour-saving machines of the very best description can now be had to perform work of the most intricate character. Hydraulic machinery is used in several yards for riveting the transverse framing, beams, &c., before these are erected in their positions, but only in isolated instances has hydraulic machinery, as yet, been applied with encouraging results to the shell and the heavier interior parts. All efforts to introduce such appliances on a more extensive scale have always proved of no avail on account of the shipbuilders' inability to change the accepted methods of carrying out the work.

It is impossible to touch on what has been achieved, by way of improvements in iron and steel shipbuilding, without referring to the writings, inventions, and labours of the late Mr. John Scott Russell, whose name will always occupy a predominant position in the history of shipbuilding. He protested, ever since the infancy of iron shipbuilding, against the manner in which the earliest builders followed the traditions of wood shipbuilding, and with his extraordinary independent mode of thought and action he set himself to work out an entirely new method, viz., the *longitudinal system*. On that principle he built his second iron vessel, the Storm, in 1834 ; and as the method of construction adopted in that craft has formed a basis for a good many suggestions with regard to the framing of vessels, it may be of interest to notice briefly the novel and ingenious contrivance out of which evolved longitudinal shipbuilding.

In the Storm the bulkheads were unusually numerous. Being spaced about the beam of the ship apart, they provided for the necessary transverse strength. The longitudinal frames consisted of T iron bars, wrought on the landings of the shell plating, so that these landings were flush plated. In larger vessels he afterwards modified this arrangement in fitting broad stringers and web frames instead of the closely-spaced bulkheads. The earliest ships built on the longitudinal system turned out to be so strong and successful in every respect, that whenever Mr. Scott Russell had his own choice he built his ships on that principle, and had the courage to prophecy that the time would come when the longitudinal system must take the lead of the transverse system. Obstacles arose, however, beyond his control, and, contrary to his anticipations, the longitudinal system is at the present day never practised in the building of mercantile vessels, except in cerain modes of framing double bottoms.

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* Foreign Abstracts Proc. Inst. C.E.

* Paper by Mr. J. Johnson, read before North-East Coast Institution of Engineers and Shipbuilders, November 23, 1888.

So much has been written—particularly by Mr. Scott Russell, whose arguments hold good at the present day—in order to point out the superiority of the longitudinal system, that it would be out of place for the writer to recall any but its most prominent advantages.

In a vessel with longitudinal framing the bow is stronger, so that in the event of collision this part of the hull is not liable to such total collapse as is mostly the case in a transversely framed ship. The vibration of the stern is spread over a larger portion of the structure, and conveyed to its stronger parts. The sides are not so readily cut down by collision; and adequate local strength anywhere in the ship can be obtained with more facility. Where unequal stresses are liable to exist—such as, for instance, in the way of bulkheads—these are distributed by means of the longitudinals over a larger surface. The engine and boiler seatings can, with considerable advantage, be secured to the longitudinal framework. The disastrous results of bilge water washing back and forward is greatly diminished.

One of Mr. Scott Russell's principal reasons for adopting the longitudinal system was, however, on account of the superior strength such a system gave in the long narrow ships of the period.

As previously mentioned, the introduction of the longitudinal system met from the very beginning with many difficulties. Chief among these were the workmen, who, trained to the old methods of carrying out work, for various reasons looked askance at any new departure from the system they had made themselves familiar with.

The registration societies have also frequently been blamed, to a certain extent, for hindering the accomplishment of new ideas in variance with their own rules and recommended modes of construction. Of this censure Lloyd's have had to take the brunt, but, on the other hand, it must not be forgotten that Lloyd's are placed in a very delicate position whenever a deviation from the old routine is contemplated. Moreover, great credit is due to them for having taken the strength of merchant ships seriously into consideration, and investigated the stresses such ships are subjected to, so that the material is now better utilised, both the longitudinal and the transverse strength more uniformly provided for, and vessels built in accordance with their rules are on the whole much stronger than formerly.

For the sake, therefore, of obtaining more strength no new system is now necessary; but another important motive, viz., the want of mechanical aid in the laying off, riveting, &c., demands an advanced method. The writer is of opinion that it will hardly ever be possible to introduce hydraulic riveting to the shell plating, unless ships are constructed on some sort of a longitudinal principle.

But before any longitudinal or other new system can be introduced, it must fulfil the following conditions compared with the present system: The cargo space not to be less; access to all parts of the iron work made easy for inspection and painting; the skin plating to be well supported; and lastly, but not least important, the weight of material and the cost of labour not to exceed but if possible to be less.

Vessels built to Lloyd's rules can be safely taken as being sufficiently strong in every respect; all that is needed, therefore, is to produce in a ship built to a new system equivalent strength to the scantlings provided for in these rules. Mr. John and other eminent authorities on the strength of ships have pointed out that there was a tendency at one time to consider that, if a vessel was made strong enough to resist longitudinal stresses, it followed as a matter of course that the transverse strength was also sufficient. But the elements of transverse and longitudinal strength are mutually dependent on each other; the rigidity of the transverse framing is responsible for the preservation of shape, and on this again largely depends the longitudinal strength.

The transverse stresses experienced by ships have not been very extensively ascertained. In a paper read before the Institution of Naval Architects, in 1882, by Messrs. P. Jenkins and T. C. Reed, this question was dealt with from a theoretical point of view in a most able manner, and their investigations show most clearly how enormously the transverse strength is increased by the use of web frames. The tendency of late years has also been to increase the number of web frames, and indeed in this some builders have exceeded the demands of Lloyd's rules, and the intermediate ordinary frames are now of use only in supplying local support to the shell plating. Web frames carrying extra strong deck beams, and spaced from 10ft. to 12ft. apart, are undoubtedly a superior arrangement for the preventing of racking strains, as their connections, or the beam arms, can be made considerably stronger than ordinary frames and beams. Besides, web frames are more rigid in resisting the deflection of the bottom and the bilges, which is due to the downward action of the weight of the sides and decks of a vessel when being docked.

The longitudinals consist chiefly of bulb-angle sections, which would probably answer best in a ship of this type. In some cases Z or T bars may be found preferable, but there are certain drawbacks in connection with adopting these sections, such as for instance, if channel bars were used it would be difficult to apply an ordinary riveting machine, and Z bars would be somewhat costly to bend and twist, unless special appliances were adopted for the purpose. T bars would be suitable where flush plating is required, although the amount of riveting would be doubled. Moreover, channel and Z bars are difficult to make tight where passing through bulkheads.

The shell plates are from 4ft. to 4ft. 6in. broad, with a longitudinal on each landing, taking the same rivets, and one intermediate longitudinal on the centre of each strake; this latter may be dispensed with at the ends where the distance between the landings tapers off to less than 2ft.

Shell packing is done away with almost entirely.

The floor plates or webs in the cellular bottom are spaced from 4ft. to 8ft. apart, depending on the amount of local strength required. It will be noticed here that the bottom plating is well supported by the longitudinals and the transverse webs.

Deck erections, such as poops, bridge houses, and forecastles, could be either constructed with broad web frames and longitudinals, or, if this arrangement was found to trespass too much on the room reserved for cabin accommodation or cargo, short frames connected to the beam arm next below it could be fitted.

The ceiling in the bottom is wrought in the ordinary way, and the cargo battens are fitted vertically and secured to the longitudinals by means of hooks or cleats.

In the prevalent transverse system, the material which constitutes the longitudinal strength is divided into the shell plating and the stringers and keelsons, with the transverse framing between them. As most of the stringers and keelsons have to be carried out to the shell plating and connected thereto, a great deal of strength is lost through having to be scored over the the frames, which arrangement is also rather costly. In this longitudinal system, which is submitted to the criticism of the members of the institution, all the longitudinals are attached to the shell, both combined giving the same longitudinal strength as if the ship was built in the ordinary way. The strong transverse web frames are all inside the longitudinals, and spaced on an average of about 12ft. apart. The web frames and the broad stringers are securely connected with diamond plates, and, independent of the shell plating, the whole framework is more rigid than the ordinary transverse framing.

It is very essential to have the shell plating as rigid as possible, since both the local and longitudinal strength to counteract the varying stresses in a seaway depends mostly on this. Buckling of the shell is better prevented with longitudinal than with transverse framing. In small vessels, or any vessel of light construction, it is difficult to keep the landing edges of the thin steel plating fair, unless these landings are supported by longitudinals in a similar manner.

The amount of furnace work would be considerably reduced. All the longitudinals are wrought as nearly as possible normal to the surface of the shell plating; they are then more efficient in strength than if bevelled.

With the exception of the bulkheads there are no transverse stations on the shell to regulate the position of the butts, and the plates can be kept equal in length, or nearly so. The shell butt straps do not require to be cut to allow the longitudinals on the centre of the strakes to pass through, but these longitudinals will be wrought over the butt straps; this will form a very efficient stiffening. The rivet holes would have to be countersunk to a standard gauge, and the rivets made with their heads to suit the same gauge, put in from the countersunk side and clenched up on the inside.

The want of mechanical aid in laying off and punching becomes here most obvious. A considerable saving of time would, no doubt, be effected if the shell, as well as deck plates, could be punched and shaped before any framework was erected. Mr. Arthur and the writer have given this question their fullest attention for some years, and have devised a system of mechanical templating and punching, whereby the accuracy and economy of workmanship is ensured, but regret that, owing to the nature of the patent laws, they are not at liberty to give particulars.

The scantlings have been modified to give the same amount of strength as Lloyd's scantlings for 100 A class.

With regard to the transverse strength, one web frame ought to be equal in strength to six ordinary Lloyd's frames and reverse frames, and the results of the calculations give :—

Moment of resistance of one plate web frame = 63·2.
" " six ordinary frames = 37·1

Which shows that the provision of transverse strength is much superior in the proposed system. The longitudinal strength of the proposed system is also slightly—about 3 per cent—stronger than the transverse system. With the scantlings as arranged on the sections the weight of iron would be about 45 tons less, or 5 to 6 per cent of the total weight of iron. In this saving of weight about 10½ tons of shell packing is included.

From this it is evident that, without decreasing the dead-weight carrying capacity, as compared to a vessel with transverse framing, the vessel in question could be made very strong by adding a trifle to the scantlings.

The erection of the structure would best be carried out in the following order : First, the keel plates and the centre keelson to be raised and the preliminary riveting in connection therewith completed. Then the bulkheads and the principal web frames to be fixed in position ; through their rigid nature they will serve as correct supports to the remainder of the framework, and no alteration of shape can take place on the stocks. Next, the longitudinals, previously punched and bent to the required shape, to go up with each strake and riveted by machinery as the work proceeds. Very few rib bands are necessary, which will in itself tend to reduce the working cost. No cumbrous framework will be in the way of the riveting machines, which can then be suspended above the vessel by means of cranes or travellers.

If machine riveting is to be successfully applied to shipbuilding, the plant must have independent supports, clear of the hull of the structure, as it is too costly to move heavy machinery of that kind—with their pipe connections—about inside a vessel.

When the height of a deck is reached, this can be built in, and the whole ironwork below it thus being finished, any cementing or woodwork in the interior may be taken in hand, instead of having to wait until the whole structure is nearly completed.

The chief aim in planning this system has been to ensure sound and accurate workmanship in plating and riveting, without being solely dependent on the varied skill of the mechanics, and to reduce the cost of production by substituting for skilled labour mechanical aid within our reach.

The writer begs to specially thank Messrs. Jos. L. Thompson and Sons for the interest they have taken in the system ; having been stimulated by the encouragement given by them, he has ventured to bring the system before the notice of the institution.

CORRESPONDENCE.

We do not hold ourselves responsible for the opinions of our Correspondents.

COMPOUND LOCOMOTIVES.

To the Editor of " The Practical Engineer."

Sir,—With your permission I should like to offer a few remarks regarding the paper read by Mr. James Bolas, of Patricroft, on " The Modern Locomotive," before the Manchester Association of Engineers, an abstract of which appeared on page 577 of your issue for Nov. 30th. Mr. Bolas stated that the latest departure in locomotive practice had been " the introduction of compounding, which, strange to say, had in most instances been applied to the express locomotive, which even when constructed in the ordinary manner always worked with a high degree of expansion, owing to the difficulty experienced in getting the exhaust steam away at the great piston speed usually maintained. The goods locomotive, to his mind, offered the better field for improvement by the use of expansive working, as these engines, with a much lower piston speed, and with the great loads they were required to haul, were mostly cutting off at from half to three-fourths the stroke." For my own part, I cannot see any difference in this respect between goods and passenger locomotives, having regard to the fact that goods locomotives are always made with less driving wheels than expresses. It is true goods locomotives do not get over the ground so quickly as expresses, which have larger driving wheels. Nevertheless, he will find that in nine cases out of ten *the piston speed of a goods engine is as much if not more than a passenger engine*, and if he rode on one of Mr. Worsdell's compounds he would find that the passenger worked more expansively than the goods, while there is less difficulty in getting rid of the exhaust in the " compounds " than in the " non-compounds." I believe Mr. Bolas is right in stating that " Mr. Worsdell's latest compound passenger locomotive is the most powerful of their class in the world," but he can hardly be aware that Mr. Worsdell has had compound goods engines at work on the North-Eastern Railway for over two years, giving excellent results both as regards economy and power. Mr. Bolas says truly that all the experiments that had been made showed there was a gain in the efficiency of compounds over non-compounds doing the same work. But he appears doubtful whether there is any gain in the end, " taking into consideration the increased first cost and the extra expense for maintenance." Now, I know from experience, that the first cost is little, if any more, at least on Mr. Worsdell's system, and while the maintenance so far has been less, there is certainly more pressure on the slide valves and the steam drier, but if properly lubricated this makes no difference in the wear and tear. Taking the boiler and tubes of compounds into consideration, I am convinced the cost of maintenance will be less. For one reason the blast is not so severe nor the heat so excessive, so that the fire-box and tubes last longer and need less repairs. With regard to the speed of a locomotive, I think Mr. Bolas's knowledge must be somewhat limited, or he would not have told his audience that in the race to the North Mr. Worsdell's compounds did their utmost, and that we had no locomotives that could or did make a trip of 100 miles on average English roads timed to run at 60 miles per hour. I think he would not have made this statement if he had read the account of the " Race to Edinburgh," which appeared on page 442 of your issue for September 14th, where it is stated that on August 31st compound No. 117 (Mr. Worsdell's) ran from Newcastle to Edinburgh, 125 miles, in 127 minutes, and was delayed 4½ minutes by signals, bringing the actual speed to 125 miles in 123½ minutes. This was done with a train of eight coaches, well laden.—Yours, &c.,

December 1st, 1888. Practical Observer.

BRAKE TRIALS OF ENGINES.

To the Editor of " The Practical Engineer."

Sir,—In your issue of Nov. 23rd there is a most erroneous statement in a letter on the above subject, signed " M.Inst.M.E.," which is liable to lead some of your readers astray if not promptly corrected. It is to the effect that a *steam* boiler working at 120lb. pressure does about 15 per cent more work than if, with the same fuel and feed supply, it works at 70lb. only. Engineers know how wrong the statement is, but it is as well to show the error. Reference to, say Rankine's steam table, tells us that the total heat of evaporation of water between 0 deg. and 320 deg. and 356 deg. respectively (a difference of 36 deg., or 2 deg. more than the case referred to in the letter) is 910,557 and 919,017 foot pounds per pound, a difference of ·93 per cent only. Taking now the heat required to raise the temperature of water from 86 deg. to 320 deg. and 356 deg., we find this to be 210,956 and 182,385 foot pounds per pound respectively, a difference of 15·7 per cent. It is here that your correspondent has made his mistake. Simply to raise the temperature of the water in the two cases may require heat to the two amounts stated as differing about 15 per cent, but steam engines are supposed to use *steam*, not hot water, and the heat of evaporation from and at 356 deg. is very considerably less than that required to evaporate from and at 320 deg. ; and the failure of your correspondent to grasp this fundamental principle in boiler and engine practice has led to the erroneous substitution of 15 for something less than 1 per cent, which is the utmost extra work performed by the higher pressed boiler. Of course at the start from a temperature of 86 deg. the higher pressure would absorb an initially greater amount of heat by the capacity of one boiler full of water only, and in any fair length of trial where many boilers full of feed would be evaporated this factor would have very limited influence indeed, and in a trial extending simply from working pressure to working pressure would be entirely eliminated. Practically, therefore, in the supposed cases the higher pressed boiler is doing $\frac{93}{100}$ths of 1 per cent more work than the other boiler, but not 15 per cent, as Mr. Harrison would have us believe. It is he, and not Mr. Anderson, who is " giving us something that is not true."—Apologising for occupying so much of your space, I am, &c.,

William H. Booth, M.Am.Soc.C.E.

Manchester, Nov. 27th, 1888.

QUERIES AND REPLIES.

Horse Power.—What are the most practical and simple rules to ascertain the nominal and effective horse power of a steam engine ? What size of pump will be required to pump 2,000 gallons of water per hour from the workings of a mine dipping 1 in 10, giving size of ram, length of stroke, and strokes per minute ?

Answer.—You can scarcely have followed our query column very closely, for the questions you put have been answered over and over again, and you will find a reply to the first portion of your inquiry in the answer to the query regarding gas engines in last week's issue, page 585. An article regarding nominal horse power appeared in our issue for June 1st last. It would be impossible to say what power would be required for the pump without knowing the exact height to which the water had to be lifted, and the precise proportions are points that would have to be settled by the engineer in charge. We cannot undertake to work out all these details. Even if we did, they would not be of much practical value unless we were in full possession of all the local circumstances.—Ed.

Ventilation of Mine.—Having noticed the questions and answers of "T. H. A." and "H." in *The Practical Engineer* of November 9th, regarding compressive ventilation of mine, may I ask how is this effected in the compressive system ? Do they close the down-cast shaft at the top, and what kind of a fan do they use ? Are there books on the compressive ventilation system ?—Important.

Answer.—The down-cast shaft is, of course, tightly closed. The method of obtaining the ventilation varies ; sometimes piston machines are used, or any blowing fan, such as Root's. There are papers and pamphlets upon the compressive system, but we are not aware of any book wholly devoted to the system, which has made no progress in this country owing to obvious disadvantages in its application.—H.

Answer.—The ordinary blowing or blast fan is the one spoken of as the compressive one, and the air-current from it is carried to that part of the mine which is contaminated with the foul air, so as to mix with it and reduce its noxious qualities, and render it non-explosive. From those parts the air makes its way to and out of the upcast shaft.—W. A.

Weighing Machines.—Is there any book published dealing specially with the construction of these machines, and what is the price?—T. D.

Answer.—I have been engaged in the manufacture of weighing machines for a considerable number of years, but I never heard of any book specially devoted to the subject.—Steelyard.

"Griffin" Gas Engine.—Will anyone who has had some experience with one of these gas engines kindly give me a few hints as to the management and cleaning of it? Also what number of lathes, 6in. centre, slotting and milling machines, I may work with a two H.P., without putting too great a strain upon it? What is the estimated consumption of gas per day of eight hours? Having lately purchased one, any information on the above points will be gratefully received by Fabricant d'Armes.

Answer.—Full particulars regarding efficiency of the Griffin gas engine were given in *The Practical Engineer* for June 15th last, page 282.

Meaning of the Term "Degree of Hardness" of Water.—Can you tell me what is meant by "a degree of hardness?" I know that hardness is due to the presence of the salts of lime and magnesia, but when a water is said to possess 23 degrees of hardness, what amount of carbonate or sulphate does this represent? What would be the equivalent expression in grains per gallon? Also, what is the difference between temporary and permanent hardness?—Chemist.

Answer.—When a water contains in solution one part by weight of carbonate of lime or other equivalent hardening salt in 100,000 parts of water, it is said to possess one degree of hardness. Since one pound contains 7,000 grains, and a gallon equals 10 pounds or 70,000 grains, it will be evident that one degree of hardness is equivalent to a solution containing $\frac{7}{10}$ of a grain per gallon. If the water possesses 23 degrees of hardness, then the equivalent expression would be $\frac{7 \times 23}{10} = 16$ grains per gallon. The difference between temporary and permanent hardness was very fully explained in an article in our last issue, explaining the action of Seale's water purifier. See page 579.—Ed.

Setting Slide Valves of Marine Engine.—Previous to setting the slide valves of a marine engine it is customary, in the shop in which I am engaged, for those in charge to ascertain from the draughtsman the position of the eccentric sheaves on the shaft or coupling. The sheave is then temporarily fastened by set-screws, as it is sometimes apt to be moved slightly when the valves are being set. The instruction is to keep the sheave a stated distance or height from the shaft or coupling. A surface gauge is generally applied from the keep of the main bearing brasses, the difference of height from the coupling being taken into consideration. Will some reader enlighten me on this method; on what principle is it based?—Primrose.

Answer.—The query is not very clear, but if I understand it aright, it refers to the setting of the sheave for lead. If a line be drawn on the sheave passing through the two centres on it, and if a mark be made on this at a given distance from centre of sheave, then by moving round the sheave on the shaft till this mark is a vertical distance above the shaft equal to that on the shop drawing, the pre-arranged lead will have been given. The vertical height is got in the drawing-office, either by drawing the required lead to scale and measuring this height, or by calculating it from the given angle of advance.—C.

Specific Gravity of Sea Water.—I should feel much indebted for assistance from you or any of your numerous readers with the following question: A vessel, consisting of a pipe closed water-tight at each end by pistons, which slide inside the pipe, thereby increasing or diminishing the total volume, floats $\frac{9}{10}$ vol. submerged in sea water, when expanded to its greatest extent. By the addition of a certain quantity of sea water the vessel is sunk just under the surface of the water. By means of the pistons its volume is now diminished, causing it to sink. Required, the proportion of this diminution to the total original volume per 100 fathoms sink? Also, How does the specific gravity of sea water vary on an average with the depth from the surface, and between what limits?—Janey.

I beg to thank "W. A." for his offer of assistance in my problem. I think, however, he misunderstands my question, which in substance is simply, What variation in the *specific gravity* of my vessel must I make in order that it may float at different depths *under* the surface? I simply gave a pipe expanded or diminished by pistons as an example.—Janey.

Answer.—The chief results of experiments on sea water are given below. Where V_1 = volume in cubic feet, under pressure p_1 in lbs. per square foot, while V_2 = volume in cubic feet of equal weight of water, under pressure p_2 lbs. per square foot, then, as per experiment, the ratio of pressure $p_2 - p_1$ to the cubical compression $\frac{V_2 - V_1}{V_1}$ is sensibly constant. This constant is termed the elasticity of volume, which may be denoted by C; its value for sea water, as determined by Couton, being 52,900,000.

If we adopt the 100 fathoms named by "Janey" as our standard or unit for depth, and let n = the number of units (100 fathoms each) of depth below the surface, it can be shown from the above law, connecting pressure and volume, that if w = the average weight of a cubic foot of water in the first unit of depth, the weight of a cubic foot of water at any depth below the surface, say n units, is $W\left(1 + \frac{1}{c}\right)^{n-1}$; or that the ratio of the average weight of the water per cubic foot in the first unit of depth, is to that of a cubic foot at any other depth (n) as 1 to $\left(1 + \frac{1}{c}\right)^{n-1}$.

The most convenient solution of the above expression is by logarithms, when it becomes $(n - 1) \times \log\left(1 + \frac{1}{c}\right)$. And since by our standard of 100 fathoms, c now becomes $\frac{52,900,000}{100 \times 6} = 88166\frac{2}{3}$, therefore $\left(1 + \frac{1}{c}\right) = \left(1 + \frac{1}{88166\frac{2}{3}}\right) = 1{\cdot}00001134$, the logarithm of which is $0{\cdot}000004922$. Whence $(n - 1) \times 0{\cdot}000004922$ = the logarithm of the density of the water at the depth (n); while the density of that in the first 100 fathoms from the surface is represented by (1) or unity. From the above we see that the value of (n) must be more than 61160 units, or the depth more than 6116000 fathoms, in order that the pressure may double the density of the water. Temperatures, of course, affects the density, but I have supposed that to be constant, or uniform.—W. A.

Concrete Floor.—Can any of your readers inform me as to the best way of preparing a concrete floor for a machine shop—the mode of mixing the cement, quantities, &c.?—Concrete.

Answer.—In reply to "Concrete," a very good concrete floor can be made by the following means: After properly levelling the ground upon which the floor is to be made, a layer of broken stones, of about 4in. deep, should be laid, then a layer of cement concrete, say 3in. thick, composed of one part of cement to eight parts of gravel and broken stone or brick, and, lastly, a layer of 2in. of cement concrete, composed of one part of cement to three parts of finely-screened gravel. This last-referred to layer must be put on immediately after a sufficient area of the underbed has been laid, which should not exceed 10 square yards at a time. Straight laths should be carefully bedded at the required levels, between which the finishing coat should be carefully levelled by a straight-edge. The whole should then be dusted over with dry cement, and neatly cleaned off and finished. The composition of each layer to be thoroughly incorporated, and mixed with water. The mixing should be done on the site, and each day's work executed with the cement prepared on that day. If the flooring be laid in very dry weather, the surface should be kept humid for 24 hours after laying by means of wet cloths. If I may be allowed to give "Concrete" my private opinion, I should say concrete flooring for a machine shop is not suitable, as if anything very heavy should drop on the floor it will crack and tear up. Again, if any grease or oil should be about the floor, it will become dangerous to walk over. A good substitute is, in my opinion, wood flooring composed of pitch pine wood blocks, say 9in. by 4in by 7in. deep, laid in a level bed of ashes, and grouted with finely-screened gravel.—G. C. P.

Changing Currents in Dynamo.—I have a series of wound dynamo of the old Gramme type under my charge, working 19 large arc lamps, and I have found lately that both carbons have craters in the ends, showing that the current must have flowed alternately; and, if this be so, the polarity of the machine must have been constantly changing. Can any reader tell me whether this is a common thing or not, and if there is any remedy for it?—T. H.

Pitch Striker for Screws.—Will someone be kind enough to favour me with instructions for making a "pitch striker," or where the tool can be bought? The use of the tool is to obtain, with certainty, a true thread by the ordinary hand chaser.—A Fitter.

Re-cutting and Tempering Taps and Dies.—I should be much obliged if any reader would give me a little information as to the process of softening, re-cutting, and tempering taps and dies.—Boltmaker.

Blacklead Pencil Making Machinery.—Can any reader inform me where to obtain the raw plumbago for making ordinary blacklead pencils, also the mode of manufacturing same, and the name of any makers of pencil machinery?—B. B.

Ventilating Fan.—A fan gives 20,000 cubic feet of air per minute, going at 30 revolutions per minute, with a water gauge of ½in., what would be the increase in quantity if the fan was going at 60 revolutions per minute, and what would be the water gauge?

If a fan fixed on the upcast discharge 20,000 cubic feet per minute, going at 30 revolutions per minute, with ½in. water gauge, and a fan of the same diameter is put on the downcast, going at the same speed, what will be the increase in quantity of air, and what would be the indication of the water gauge? The fan on the downcast is forcing, and the fan on the upcast drawing.—J. W.

Electricity.—I have a slight knowledge of electricity, and should be glad if some of your numerous readers would kindly tell me the best work to study in order to extend my knowledge. I should like one to start from the very beginning and lead up to the various formulæ for leads, dynamo, accumulators, &c., and hints for fitting up installations and management of same.—J. P. W.

Varnish for Papier-Mache Goods.—Would some reader kindly inform me how to make the black varnish that papier-mache goods are coated with? I want it so that it will not peel off the card. How is the glaze put on after the goods are varnished?—J. T. L.

Turnham.—We have received a letter from "Gyrtona," requesting us to convey his thanks for the answer to his query *re* diagram of stress for girder.—[Ed]

TO CORRESPONDENTS.

F. Webb.—Such matters as you seek information about cannot be taught by correspondence. If you don't know how to start an engine, we should hardly think you are qualified to mind one.

T. G. W.—It is somewhat difficult to answer your question. The choice of the types of crank you describe is very largely a matter of taste, and whether one or another would be preferred would depend on the individual predilections of the engineer. The crank shown in fig. 2 would, we should think, from its simple shape be the easier to build. With regard to the method of securing the crank pin shown in fig. 1, if we understand you rightly, it would be secured with keys as well as with nuts. It may be of convenience to refer you to a method of securing crank pins so as to permit of their ready removal, which was shown in our issue for June 8th last, page 273.

Morland.—If you will carefully read the answer regarding horse power of gas engine given in our last issue, page 585, you will find the principles on which the answer to your inquiry is based. It is impossible to say what horse power is being developed by an engine without taking an indicated diagram. The calculation is the same in every case, and you will find full information on the page we refer to.

Roll-turner.—We are not aware of the existence of any book dealing specially with the subject you refer to.

W. T. R.—Your question is not very clear, and it is not easy to make out what kind of book you seek. There is a text book on applied mechanics, by Messrs. Cryer and Jordan, price 3s., which would probably be of service to you. You will find particulars on our front page, and the book may be obtained through this office.

Parker.—The term "vacuum," as used by engineers, is only a relative one; that is to say, that in speaking of a vacuum of 12lb. a pressure 12lb. less than the atmosphere is meant, so that there would still be an absolute pressure of such a vessel of 3lb. Such a thing as an absolute vacuum in the case of a steam engine is not possible.

J. S.—We should think you ought to be able to get such a fitting from any brassfinisher, but if you have any difficulty, communicate with Messrs. Isaac Storey and Sons, Cathedral Yard, Manchester. We have no doubt they would be able to supply you.

MISCELLANEA.

Bursting of a Logwood Extractor.—On Thursday, the 29th ult., two men in the employ of Messrs. Campbell and Co., Friarton Dyeworks, Perth, were seriously scalded about the face and arms by the bursting of a logwood extractor.

Panama Ship Canal.—Mr. De Lesseps has issued an appeal to his fellow-countrymen to take up the remainder of the lottery bonds of this undertaking, and states that if the issue is fully subscribed for, all anxiety as to the completion of the work may be laid aside.

Restriction of Coal Output.—All the collieries throughout South Wales and Monmouthshire were brought to a standstill on Monday last, in consequence of the workmen having decided to restrict the output. It is proposed to take a holiday each month, and Monday was the first.

The Great Eastern.—The total receipts realised by the sale of the Great Eastern amounted to £58,000. Among the buyers were shipowners and merchants from all parts of the United Kingdom and abroad. The dismantling of the great vessel will commence in a few weeks' time, and it is expected that the work will occupy over 18 months. The vessel was purchased by the vendors, Messrs. Bath and Co., Liverpool, for £16,000.

Mine Managers' Certificates.—The *London Gazette* contains the announcement that the Home Secretary has, under the Coal Mines Regulation Act, 1887, directed that the sum of 5s. shall be the fee to be paid in respect of a certified copy of a first-class certificate of competency, of a certificate of service as manager of a mine under the Coal Mines Act, 1887, and that the sum of 2s. 6d. shall be the fee to be paid in respect of the issue of a certified copy of a second-class certificate, whether of competency or of service as under-manager of a mine under the said Act.

The Midland Wages Board.—Considerable dissatisfaction is expressed by the ironworkers in the Midland districts at the unsatisfactory relationship existing between the Wages Board and the general body of ironworkers, and the attention of the West Bromwich Association has been called to the matter in consequence of so many of the employers and workmen having withdrawn their support from the board. Out of sixteen ironworks in West Bromwich, only five, it is said, are connected with the board. Considerable dissatisfaction is expressed by some at the election of operative representatives. On the other hand, leaders of the operatives complain that while in some cases the men are willing to support the action of the board, the employers decline to have anything to do with it. It is reported that some of the employers are not paying the advance recently awarded by the arbitrator.

King's College Engineering Society, London.—At a general meeting of this society, held on Tuesday, November 20, the president in the chair, Mr. Paulson read a paper on the History of Railway Systems. The author commenced by stating that railways are an English invention; first originating about Newcastle, in the 17th century, and were employed in bringing coal to the shipping from the pits. He then described the various kinds of rails, from the cast-iron rails of Coalbrookdale (1767), and the rectangular wrought-iron rails of 1805, to Mr. Birkenshaw's method in 1820, whereby rails of any required section may be rolled; and went on to deal with the history of the locomotive, many of his statements throwing an interesting light on its early history and development. After pointing out the advantages which railways possess over canals, he proceeded to describe the various signalling systems used in England, giving the details of the block system, Mr. Saxeby's interlocking system, and Mr. Hodgson's combination of the above, whereby the train itself exercises control over the signalmen. After mentioning the mountain railway systems of Peru, he concluded with a reference to the proposed overland route to India. After a vote of thanks to Mr. Paulson, the meeting adjourned.

The Paris Exhibition.—On Friday last, a meeting of the Executive Council of the British Section of the Paris Exhibition, 1889, was held at the Mansion House. Mr. H. Trueman Wood, one of the secretaries, reported that the whole of the space placed at the disposal of the British Section had been allotted among exhibitors. Various colonies had desired to participate, but the most urgent appeals to the French authorities had failed in obtaining any extension of the original amount of space granted. Sir Frederick Leighton, P.R.A., adverting to the Fine Art Section, said that in view of the fact that in Paris in 1878 England had been represented very worthily in matters of art, and obtained very considerable renown and reputation, which had been maintained by the Art Sections at Munich and Berlin, it would be damaging if British art was not well and excellently represented next year, and he hoped the council could see their way to increasing their grant for the Art Section. Sir J. D. Linton, P. R. I., concurred in the views of Sir F. Leighton, and the council unanimously voted, including previous grants and donations, £2,000 towards the expenses of the Art Section. Afterwards it was resolved unanimously—"That Sir Polydore De Keyser be nominated executive president and Mr. H. Trueman Wood *commissaire délègue* of the council of Paris."

The Plumbers' Company.—At a banquet given by this company in the Saddlers' Hall, Cheapside, on the 26th ult., the Master, in proposing the health of the Lord Mayor, sketched at some length the origin of the Plumbers' Company, and the progress which had been made in the movement for the better education and registration of plumbers. In 1884 a congress was held, at which a number of London and provincial plumbers met, and from that beginning the present movement sprung. The contract system had been mentioned at that congress as one of the chief objects of reform, and he thought that the cause of the execration of modern plumbers lay in the ignorance of the public that they did not carry out their own plans, but those of other people, who were often grossly incompetent. The numbers registered were increasing year by year, and the examinations were being made more frequent. To show the value of these, he mentioned that in some examinations as many as 75 per cent of the applicants failed to pass, and at the last held only one-third of the candidates succeeded in passing. The Lord Mayor, in responding, said that the great want of the day was more perfect sanitation, and he believed that the Plumbers' Company were going the right way to attain that end. The means at the disposal of the company were small, but he would propose that they should fall back on one or more of the rich companies, and then they might see the influence of the Plumbers' Company spread over all parts of the United Kingdom. The toast of "Sanitary Science and Technical Education," proposed by Sir M. E. Grant-Duff, was responded to by Dr. George Buchanan and Sir P. Mangus. The latter mentioned that some 700 students were at present receiving in London instruction in the very subjects to which the master had referred.

SELECTED PATENTS.

APPLICATIONS FOR LETTERS PATENT.

November 20th.

16840 Steam Generators, W. M. Brown and S. W. Whitmore, London.—[Complete Specification.]
16853 Fire Bars, D. B. Morison, Hartlepool.
16854 Dressing Tin, &c., G. M. Edwards and W. J. Griffiths, Blackheath.
16858 Injector Stop Tap, A. Craven, F. Craven, W. Pinder, and P. H. Stansfield, Bradford.
16861 Snow Ploughs, A. J. Boult, Middlesex. (O. Jull, Canada.)—[Complete Specification.]
16865 Rolling Spades, A. J. Boult, Middlesex. (J. Huertas, Spaiu.)
16868 Indicating Position of Railway Points, C. R. Galwey, London,
16883 Flexible Packing, J. T. Hinton, London.
16887 Mining Pumps, W. Keast, C. Budge, and R. Wilkinson, London.
16890 Teaching Applied Mechanics, E. Barry, London.
16893 Shipping Coal, W. Shapton, London.
16895 Signalling Apparatus, A. Glen, London.

November 21st.

16896 Wood-planing Machines, D. Thomson, Glasgow.
16908 Railway Signals, R. Todd, Manchester.
16909 Marine Boilers, P. Ferguson and W. Y. Fleming, Glasgow.
16912 Valve or Cock, H. Brecknell, Bristol.
16916 Aluminium, T. Parker and A. E. Robinson, Manchester.
16917 Screw Propellers, G. Chapman, Glasgow.
16928 Brushes and Contacts, R. R. Hutchinson, London.
16932 Rolls, G. Tidcombe, London.
16943 Esparto Grass, J. Mactear, London.
16945 Locking Apparatus, S. Brown, London.
16948 Steam Engines, H. Gourlay, London.
16952 Cam Spring Box File, A. E. Walker, London.

November 22nd.

16977 Cleaning Fire Tubes, W. Cooke, Liverpool.
16983 Packing Rings, J. Meseley and B. Blundstonc, Manchester.
16986 Elevator Chains, R. Morris and J. Wood, Doncastcr.
16993 Lock Nuts, W. Chattaway, Birmingham.
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17013 Electric Meters, C. Watson, London.
17014 Blast Pipes, C. Adams and G. Macallan, London.

November 23rd.

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17028 Drain Cock, R. W. Fieldwick and G. F. Harvey, Manchester.
17031 Filter Presses, S. H. Johnson and C. C. Hutchinson, Stratford.
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17050 Twisting Spiral Cutters, H. Smith, Sheffield.
17051 Friction Clutches, J. H. Shorrock, London.
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17061 Straightening Angle Bars, L. Richards, London.
17062 Flexible Mouldings, T. Birnbaum, London.
17067 Separating Metal, H. H. Lake, London. (O. B. Peck, United States.)—[Complete Specification.]
17071 Refrigerating Machinery, F. B. Hill and J. Sinclair, London.

November 24th.

17085 Hot-air Engines, A. Fehlen, of the firm of W. G. Mac Ivy, London.
17090 Type-writing Machines, G. C. Dymond, Liverpool. (A. Von Brandis, United States.)
17093 Slide-valve Appliances, E. A. Slade, South Shields.
17095 Tap or Cock, J. Robinson and W. Murray, Penrhyn.
17098 Nut-locks, T. W. Willis and J. Tuxford, Sheffield.
17101 Lubricating Engine Crank Pins, J. Pease, Appcrley Bridge.
17102 Gas Producers, G. Scott, Glasgow.
17105 Gearing, J. Laidlaw, Glasgow.
17110 Fog Signalling Apparatus, A. M. Malloch, Glasgow.
17112 Compressed-air Engines, C. Wells, Middlesex.
17115 Lathes, E. Bennett and E. J. P. Ravet, Middlesex.
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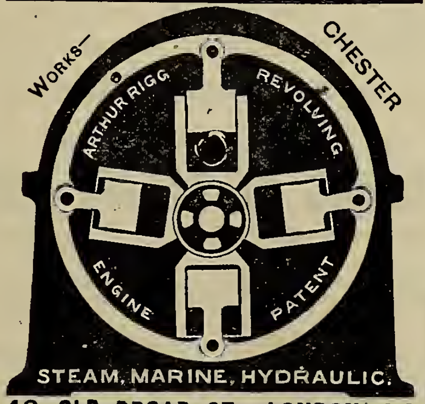

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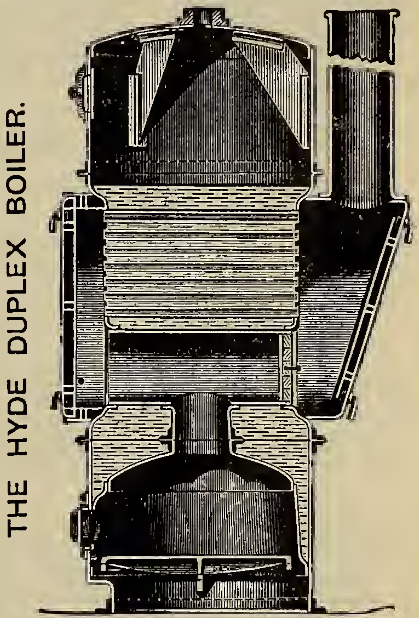

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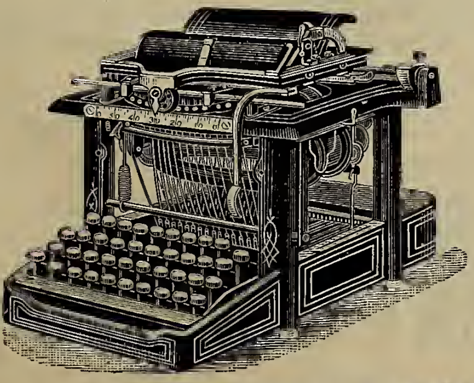

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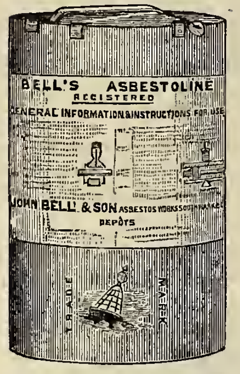
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Numerous complaints having been made to us by Subscribers of the difficulty they experience in obtaining copies of *The Practical Engineer* in certain districts, we have to state that the Journal can be obtained by any Newsagent through the ordinary trade channels, and no difficulty should therefore exist in obtaining copies *by order* of any Newsagent.

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EDITORIAL NOTICES.

All communications for the Editor of this Journal should be addressed to 6, Victoria Station Approach, Manchester.

Communications intended for insertion in the current week's issue should reach us not later than Tuesday Evening.

We cannot undertake to return rejected manuscripts or drawings unless accompanied by a stamped and directed envelope.

Contributors are requested to write on one side only of the paper. Sketches should be sent on separate sheets.

TO ADVERTISERS.

Advertisements intended for insertion in the current issue should reach our Manchester Office on Wednesday Morning *at the latest.*

THE
PRACTICAL ENGINEER.
DECEMBER 14TH, 1888.

PROFESSIONAL SINECURES.

In the engineering profession there has long existed in various quarters a state of affairs which certainly reflects no credit upon it, and one which, if widely prevalent, would be calculated to bring it into general contempt, and that is the appointment, through influence or interest, of men to positions for which they are practically unqualified. This practice, we may say, occurs to a much greater extent in the civil than the mechanical branches of the profession, though there are some striking examples in the latter section. In dealing with this matter our remarks are not hastily conceived, but based on a careful personal observation extending over a long period of years.

In this connection there are several points to be considered, but according to the spirit of the times the financial one stands first. Now, it is perfectly obvious that if a man be forced into a position the duties pertaining to which he is incapable of performing, other and competent men must be employed to do his work for him, and therefore his salary is a dead loss to the proprietors of the undertaking, whatever it may be. Further than this, his position as chief gives him an authority which may be and is frequently used in a manner injurious to the interests of his employers. Thinking it necessary to impress his importance, or rather what should be the importance of his position, upon his subordinates, he seeks by excessive zeal with respect to trumpery details to hide his ignorance of broad outlines, and makes petty alterations in well-considered designs, which materially impair their efficiency, and in the majority of cases also add to their cost. If such conditions must exist, the least dangerous man is undoubtedly he who, satisfied with his sinecure, is content to receive his pay and let his subordinates do the work unhampered by his interference and fads. All he then has to do is to learn enough generally of the affairs he is supposed to control to enable him to talk to his directors, who will very seldom trouble him about details, and, should even these confront him, he can get time to prepare his (?) report, to be laid before a subsequent meeting of the board.

It were useless to refer particularly to the absurdly small emolument frequently received by those who really do the work as compared with that of the chief. Under the existing commercial system we must confess we see little prospect of amendment.

Another matter which, from a professional point of view, is worthy of attention, is the certainty of such men as those to whom we refer degrading their positions if they interfere at all with the technical duties of their offices. Uncertain as to the work of their assistants, because unable themselves to revise it, they fall back upon the contractors for advice in regard to the work entrusted to them, and perhaps even consult their inspectors in order to have a further check. In saying this we imply no disrespect to the contractors, for it is a matter of course that they, having to actually execute work, must be thoroughly acquainted with all the details in their respective branches; but it is certainly contrary to professional etiquette for a company's engineer to take the contractor as his consulting engineer. If in any case this position is unavoidable, then it would certainly be to the company's interest to displace their own engineer as useless and entrust the whole work to the contractor.

So far as the inspecting engineer is concerned, he, of course, has no independent authority whatever, being strictly tied down by the provisions of the specification under which the contract is let.

It is not, however, only among engineers in the higher positions that we find certain members who are under the necessity of relying upon intellectual assistance. Numerous cases have come under our notice of subordinates who, by influence, have been forced into situations they were totally unfitted to fill, and generally at a higher rate of salary than that received by competent men of their class. We have indeed known of a few cases in which such assistants have during the whole period of employment hardly designed a single work that could be executed; their drawings have been thrown aside, and others prepared by men practically acquainted with the work.

These, of course, are extreme cases, and it does not necessarily follow because a man is helped into position by his friends that he is incompetent, and even if he be inexperienced, it is possible to repair that defect in time by hard work; so that if he is really fond of the profession he may pull through with such aid as he will surely find in every well-appointed office, and ultimately qualify himself to undertake the highest responsibilities with confidence.

While dealing with intellectual aids, we must say a word about engineers' pocket-books and other works of this class. In their proper place such aids are of great value in economising time, but in some cases their use may lead to serious error. The tabular portions of these works are almost indispensable to the engineer occupied in daily calculation, and those in which formulæ are recorded are of great assistance to such as have enfeebled memories; but in no case should the latter be used by anyone who is not acquainted with the principles and data upon which the formulæ are based before the pocket-book is adopted as a remembrancer.

In order to impress the necessity of thus checking the formulæ upon young engineers, we may mention that for many years an error in a constructive formula ran through several editions of a pocket-book, which was certainly equal to any of its contemporaries; and in this case, curiously enough, the student who did check the formula might easily be misled, as the same error on the same subject occurred in the statement of theory in some scientific text-books written by high academical authorities. This error was, however, we are glad to say, eventually corrected in the pocket-book.

It will naturally be asked how the matters complained of in this article could be rectified, and we must confess it is easier to point out the evil than to suggest a remedy. It is easy to say that some guarantee of an engineer's ability should be given before he can be employed. The difficulty is to decide upon the nature of the guarantee. To say that a man has been employed for so many years on works may count for little or nothing. It only indicates that he has had the *opportunity of acquiring* experience, not that he *has acquired it*. We personally remember one case in which a man was described as having been resident engineer for so many years on a railway. The fact was he drew the pay, but never touched the work; indoor men designed the works, while an outdoor sub-resident set them out and superintended their execution.

On the other hand, we are not much impressed with the value of examinations on the academical system as a means of testing a man's engineering abilities. Such tests may prove the possession of a certain amount of mental agility, but much of this wears off when a man leaves his college gymnastics and takes up the engineering profession in grim earnest. We do not wish it to be understood that we disparage the importance of a sound theoretical training, but something more than mere ability to pass a college examination is required to prove that a man is an engineer. If examination is to be relied upon as a test of an engineer's competency, it should be of such a nature as to ascertain whether, after some definite term of service on actual works, he has acquired the practical knowledge for which opportunity has been afforded.

THE NAIL AND SMALL CHAIN MAKERS.

In reference to the leader which appeared in our last issue, it is of interest to note that the Home Secretary stated, in reply to a question which was put to him in the House, that it is the intention of the Lords' Committee now pursuing its investigations with regard to the sweating system to extend its inquiry into the condition of the nail and chain makers of Cradley Heath and its neighbourhood. We stated in our article that, to our minds, the extension of the inquiry by the present House of Lords' Committee was the "suggestion in which we should be disposed to place most hope," and we are glad to learn that it is to be adopted.

MARINE ENGINE CRANK AND SCREW SHAFTING.

The formulæ recently issued by Lloyd's Committee to their surveyors for ascertaining the working pressure which may be allowed on crank shafts appeared on page 365, along with the formulæ of the Board of Trade, with a suggestion that some of our readers might give an opinion on its practicability. The subject has been referred to on two occasions since then (pages 415 and 454) by the publication of valuable tables of sizes under different conditions.

The object of the present article is to discuss the application of Lloyd's rule to engines of the two-cylinder compound type, which may be converted into the triple-compound type.

A large number of vessels afloat have engines and boilers which have done good service in the past, and in the ordinary course of events will ere long require their boilers renewing. Such an opportunity would be highly favourable for having the engines altered so as to work on the triple-expansion system. The extra outlay would be compensated by the economy of consumption, which in some cases has amounted to 30 per cent, the money value of which is considerable, as it means so much less coal to purchase abroad during the voyage.

As an illustration, let us consider the case of what were known as 150 nominal horse power engines (a size which found considerable favour a few years ago), developing probably a maximum of 800 indicated horse power (I.H.P.), with, say, one 33in. and one 62in. cylinder, by 36in. stroke, running at 65 (n) revolutions, and boiler pressure of 80lb. per square inch. The crank shaft for such an engine by the old Board of Trade rule for compound engines, with cranks set at 90 deg., requires to be 10·18in., say $10\frac{1}{4}$in. diameter.

The cheapest method of converting these engines would be to add a new high-pressure engine complete at the forward end with boiler steam at 160lb. per square inch, and retain the old engines intact; arranging the cut-off in the high-pressure cylinder so that the same total I.H.P. is given out.

By making the ratio $\frac{\text{I.P.}}{\text{H.P.}} = 2{\cdot}6$, we get $\frac{855{\cdot}3}{2{\cdot}6} = 329$ square inches, as the area of the high-pressure cylinder; or, say 20·5in. diameter, while the ratio $\frac{\text{L.P.}}{\text{H.P.}} = \frac{3019{\cdot}1}{330} = 9{\cdot}148$.

Applying the formulæ to find the diameter of crank shaft required for a triple-expansion engine of these dimensions, we have:

By Lloyd's rule ....$d = \sqrt[3]{\frac{175 \times 36 \times 3844}{18800}} = 10{\cdot}88$in. diam.

" Board of Trade rule...$d = \sqrt[3]{\frac{175 \times 18 \times 3844}{1110 \times 11{\cdot}14}} = 9{\cdot}93$in. diam.

That is to say, in the former case, in order to pass Lloyd's, the shaft would have to be enlarged ·63in., although the I.H.P. under the altered conditions is exactly the same as before; while on the other hand, the Board of Trade would accept a shaft ·32in. less than the original diameter. The latter modification is what might reasonably be expected, for in triple engines, with cranks set at 120 deg., it is generally recognised that the strains are not so severe as in the compound, with cranks set at 90 deg.

In order to ascertain the fairness or otherwise of the modification introduced by Lloyd's, it is of interest to compare the stress on the material of the shafts, as found by the formulæ used above. To do this it is necessary to consider the twisting moment on the shaft, with the engines working at full power.

The *mean* twisting moment in inch lbs. is found from the equation $12 \times 33000 \times \text{I.H.P.} = 2\pi rpn$, where p = the twisting force in lbs., acting at a radius of r inches, and n = the revolutions per minute. From this is deduced the well-known formula, $pr = \frac{63024\,\text{I.H.P.}}{n}$. Now pr = the mean twisting moment, and substituting the values of the symbols, we get $pr = \frac{63024 \times 800}{65}$ = 775680in. lbs. This, however, is not constant for the whole stroke, and the shaft must be made suitable for the *maximum* twisting moment (T.M.), which for triple engines is about 20 per cent in excess of the mean; $\therefore$ T.M. $= \frac{775680 \times 120}{120} = 930816$ inch lbs.

The T.M. which a bar will stand before rupture occurs is found from the formula T.M. $= f_t \cdot 196d^3$, where f_t is the ultimate shearing stress of the material, and $\cdot 196d^3$ the modulus of resistance of a circular section to resist torsion, which was explained in our issue of April 27th, page 195.

The value of f_t is given by Rankine at 50000lb. per square inch. By transposition, the actual stress on the shaft by Lloyd's $= \frac{930816}{\cdot196 \times 10\cdot88^3} = 3686$lb. per square inch, and $\frac{50000}{3686} = 13\cdot5$ as the safety factor.

By the Board of Trade rule, the stress $= \frac{930816}{\cdot196 \times 9\cdot93^3} = 4842$lb. per square inch or 10·3 factor, the former being 31 per cent in excess of the latter.

It will, we think, be admitted that a factor of 10 is amply sufficient, especially if the practical evidence furnished by the satisfactory working of the large number of shafts which have been constructed to the Board of Trade rule be taken into account. The writer only remembers one case of a crank shaft constructed according to the Board of Trade rule, and it may be mentioned that the Board of Trade factor of safety would have been accepted by Lloyd's surveyors until the issue of their rule a few months ago. Government departments are generally credited with demanding exceptionally high factors of safety, but in the matter of crank shafts the authorities at Lloyd's are now decidedly more exacting.

The question arises in such a case as the one considered above, whether Lloyd's would insist upon the extra diameter of crank shaft? The power given out is precisely the same as that at which the engines have probably been running for ten years. There would be ample time for the shaft to fail if it were too weak, and it therefore seems absurd to expect owners, with the keen competition existing at present, to go to the extra expense of renewing the whole of the shafting, bearings, &c.

Supposing the shaft is retained, there are two alternatives open, either to reduce the boiler pressure or to reduce the diameter of the low-pressure cylinder. If the boiler pressure be reduced to $P = \frac{18800 \times 10\cdot25^3}{36 \times 3844} - 15 = 131\cdot3$lb. per square inch, it would hardly be advisable to retain the ratio of low-pressure to high-pressure cylinders of 9·148; while if the boiler pressure is maintained at 160lb. per square inch, the diameter of the low-pressure cylinder would have to be reduced to $D = \sqrt[2]{\frac{18800 \times 10\cdot25^3}{36 \times 175}} =$ say $56\frac{5}{8}$in.

This would necessitate a liner being fitted to the existing cylinder, as well as a new piston and cover. The additional outlay involved by these alterations would be enough to deter most owners from adopting the triple-expansion system, at least to any great extent. It may here be stated that the large companies, popularly termed liners, are not referred to in these remarks, but owners of ordinary merchant vessels.

The conclusion of the consideration of the case taken, coupled with what has already been published in these columns on the subject, fully shows that Lloyd's rule as it now stands is not a practical one, and should be modified so as to include the ratio of cylinders, or at least the ratio $\frac{\text{L.P.}}{\text{H.P.}}$, on which depends to a great extent the total range or expansion; for whereas the Board of Trade rule was received by engine builders as fair and reasonable, this is regarded as excessive in its demands, and, if adhered to, will cause considerable dissatisfaction.

Finally, it may be stated that in engine works of good standing it is customary now to employ mild steel in the construction of crank shafts, so that although no allowance is made in either formula for the extra strength thus obtained, yet the actual factor of safety will be higher than those found above.

AN ENGINEER'S LIFE AT SEA.—XIX.

BY A SEA-GOING ENGINEER.

To ascertain top end clearance several methods are used. One is to turn the piston to the top and measure the clearance with the cover off, making allowance for all projections or recesses in it. Another way is to stand short lengths of candle in various positions on the top of the piston; and for this purpose composite candles are better than tallow ones. The cover is then put on and taken off, when the candles will be found crushed to the space of clearance. Small cones of red-lead putty are sometimes used, but frequently mislead, as they display a remarkable facility in bending under the pressure and springing back when this is removed. In one case nearly two inches clearance were shown, when in reality there was less than an inch. Another way, as good as any, is to lower the piston an inch or two by turning the engines, and to lay three large nuts on it where the clearance is seen to be least. Then, with the cover laid on, the piston is turned up again to the top, lifting the cover with it, and the rise of the cover subtracted from the thickness of the nuts gives the required clearance.

The wear of valves on their faces should always be noted, with a view to the rods being kept from bottoming in their slots. When this occurs, it tends to keep the valves off their faces, and by bending the rods causes the link motion to rattle and work laboriously; and such bending has, in some cases, led to the breaking of the collar brasses in the valve-spindle stuffing boxes. With too soft a cylinder or valve face, this wear may be rapid, and necessitate a gun-metal face being pinned on the cylinder. To reduce the pressure of the valve on its face, back-balance arrangements are sometimes fitted; but with engines of the size under consideration these are in most cases superfluous, giving more trouble than they are worth, if they are kept in working order at all by the engineers. The valve bears hardest on its face just before compression begins at the one end, and when the pressure in the cylinder at the other end has been reduced by expansion. The pressure holding the valve on its face is found by subtracting the back pressure in the cylinder and exhaust port from the steam pressure, keeping the valve down. To get this latter, the pressure per square inch in the casing must be multiplied by the area of the two steam ports in the cylinder, plus the exhaust port in the valve. The capacity of this exhaust chamber does not affect the result, nor has the size of the exhaust port in the cylinder any direct connection with it. The total pressure having been thus arrived at, the back pressure to be subtracted may be thus obtained. The area of the exhaust port in the valve multiplied by the pressure of the exhaust, as shown on the diagram, gives part of it. The remaining part can be got roughly by estimation, or more accurately from the usual double diagram by measuring the pressure at the point where the exhaust line from one end of the cylinder cuts the compression line from the other end. This back pressure must be multiplied by the area of *both* steam ports, and then added to the back pressure previously obtained. This sum subtracted from the steam load on the valve previously obtained will give the maximum pressure on the valve. Of course, the pressure of the atmosphere must be allowed for if the calculation is for the low-pressure valve. To get the minimum pressure, the rule found in some text-books may be used, viz., "Add the area of the valve port to the area of one steam port, and multiply the sum by the effective pressure of the steam." Though this gives a higher pressure per square inch than when the valve is about the middle of its travel, the back pressure of exhaust being lower, yet, owing to both ports coming into play in the middle position, the pressure on the valve is greatest there.

Near the middle of the stroke the pressure is equally distributed, but if the valve be traced on its course there will be found a shifting of the centre of pressure, causing it to oscillate now to one side, now to the other side of the centre of the valve. This slight tendency to rock is immaterial, unless compression becomes excessive, in which case the valve is lifted off its face at one end to fall back again to its place with a sharp clap. In the middle of the travel, where the load is greatest, there is also the least rubbing surface in operation, and therefore the pressure per square inch of the valve on its face is thus further increased. But as the valve is here also at its greatest speed of travel, everything has combined to increase the wear due to friction. The oscillation of the centre of pressure also tends to hollow out the middle of the cylinder face, and to round the edges of the valve. A steel straightedge will show these defects when they exist, and in some cases, where scoring has begun, smoothing with a file is necessary to prevent further mischief. Though a leaky valve has less load on it than a tight one, its faces soon get cut up with the steam. By immediately stopping any leak on its first appearance, and keeping the valve well lubricated, the life of both valve and cylinder faces will be of the longest.

When the valve is replaced in position, and before driving home its cotter, it must be shoved hard up against the cylinder face. If this be not done, the strain on the cotter will almost certainly throw it off its face again. Where such occurs at the bottom edge only, it is easily overlooked, especially if not expected. The cotter being driven home and secured by its split pins, the shores may then be removed, and the valve will be found tight on its face. A good supply of cylinder oil having previously been given to it, and all obstructions carefully removed, it is at once closed up to prevent accident.

Where an expansion valve is on the back of the main slide, it is as well to try its effect when linked up and the engines set to "astern." This can be done easily, whatever the direction in which the engines are being turned, by putting over the link to astern and noting the relative position of valves and cranks all the way round. If an ordinary expansion valve is in, it will be found to have no effect whatever on the engines when going astern. If, however, engines are linked up at sea, they will be opened up on going into port, so as to start and reverse readily. Omission of this may lead to trouble, as once when a steamer had to be stopped at sea for a breakdown. The chief — a bigoted man—came below to show the other engineers how the engines should be handled. But the engines would not start for him, and it was only after much toil with the starting wheel and steam handles that they were at last got under way. The chief having retired somewhat crestfallen, it turned out that a wooden wedge put in at the back end of the high-pressure radius rod to link up its valve had been forgotten, and though the second had noticed this after the trouble began, he did not speak of it in hopes of avoiding the explosion of wrath which would have put the blame on every one but the chief offender himself. No one ever told him of it, but that was the last time he came down to give instructions in starting engines. This incident also shows the disadvantages such overbearing men put themselves under.

On arrival in port it is usual to blow out the packing, and thus to save time and work with the packing hooks and screws. It is well to have a number of lengths always ready cut. This can be done by measuring the diameter of the piston rod in port, and noting the length of packing required. A still better plan is to get a "bouilli," or preserved-fruit tin, of the same diameter as the rod, or a circle of wood, and to keep this for the purpose of measuring the packing when at sea. The high-pressure stuffing boxes are usually packed with "Tucks," the low-pressure ones either with alternate layers of this and spun-yarn gasket, or with the gasket alone, though a turn of the other is usually put in first to prevent the spun yarn getting through. Of various kinds of plats, square, round, and flat, every engineer should know something, and thus be independent of his men. For packing buckets the plats are usually made as close as possible, and drawn tightly round the bucket, and when the rounds have been caulked in and the end secured in the hole made for the purpose, if then found too tight to enter, it may be singed round with a hot iron, and this, by removing inequalities, will make it more air and water tight.

When the pumps have been closed up, and the "third" is overhauling the links, he will find that much depends on the readiness with which he can estimate the thickness of liners required. When he cannot get the exact thickness otherwise, he may have to put in a brown paper line. By practice he will be able to determine, by tightening up one link and trying the shake, whether both bolts can be tightened hard up or not, taking care, of course, that the brasses are parallel, and the nuts hard home.

When in port a "third" cannot keep his eyes too wide open. He will see bolts and brasses and all sorts of odds and ends produced from the bottom of waste lockers, or from out-of-the-way shelves of stores. It will be well for him if he has already peered into every hole and corner, and tried to find out the use of everything without making too many inquiries. In any case, he will get much information by keeping his eyes open while the work is proceeding, though his mouth may be shut. In breakdowns at sea, the knowledge of where everything is kept will be invaluable to him. Of course it is taken for granted that both the "chief" and "second" will try to outrival each other in their knowledge of the exact place and use of everything in the engine-room. When a breakdown takes place at sea, the time of stoppage and the repairs done have to be logged. Thus, even in mid-ocean, the engineers know that the eye of the superintending engineer on shore is upon them, and that he will make no allowance for the time spent in searching for duplicate parts or tools, which they should have been able to get at without delay. Breakdowns always try the mettle of a man, and by a process of sifting out the inefficient they will usually put the best men to the top, and keep them there, and it is chiefly by close attention and observation that one man excels another.

Electrical Deposition of Heavy Metals.—The following method for the electrical deposition of the heavy metals, such as platinum, iridium, paladium, &c., has recently been proposed by Prof. Silvanus Thompson. The impure metal is first obtained as a chloride by the ordinary chemical processes. The excess of acid is evaporated off in a water bath, and the salt finally re-dissolved in distilled water and from ten to fifty times its weight of a solution of sodium phosphate either pure or mixed with borax. The solution is then raised to the boiling point, and sal ammoniac, common salt, or sodium bromide added. The solution is then re-heated, and finally neutralised with either the carbonate, or, if alkaline, with the bicarbonate of soda. In depositing the metal from a bath of the above solution, it should be heated to from 60° to 90° Cent., and the metal deposited in the ordinary way. In the case of platinum a brilliant deposit can be obtained from a bath of the following composition: Chloride of platinum, 2 parts; sodium borate, 16; sodium carbonate, 16; sal ammoniac, 2; water, 150.

HELICAL GEARS.—II.

There is no difference in the fundamental principles and methods of striking out the teeth of common and helical gears. In each case the practice is to employ cycloidal teeth, which are superior in every way for purposes of general work to the involutes, or to teeth struck by rule of thumb. This is not the opportunity to enter into a detailed account of the various forms of teeth which the application of the cycloid form of curve is capable of producing. It must suffice to say that if a generating circle be rolled upon a base circle, then a point in the periphery of the generating circle will describe a cycloidal curve. The sweep of that curve will depend on the proportions which the radii of the generating and base circles bear to one another. Hence the cycloid curve can be varied to suit any requirements of strength of tooth, so far as that is affected by breadth of root, or of length of arc of contact. Further, if for a set of wheels a uniform size of describing circle is employed for roots and flanks alike, then any pair of such a set will gear together with absolute correctness. In practice, the diameter of the generating circle is made equal to the radius of the smallest wheel of any set, and this gives radial flanks to the smallest wheel. But for special pairs of gears the generating circle is often selected to give flanks stronger than the radial form affords, and it is sometimes convenient, in wheels greatly disproportionate in diameter, to choose two sizes of circles, one for roots of wheel and points of pinion, the other for points of wheel and roots of pinion. But, in any case, the gears so struck with a common generating circle will work with absolute precision, and the lines of the mutual pressure of the teeth will always pass through the pitch point, as it must to produce the most regular motion attainable.

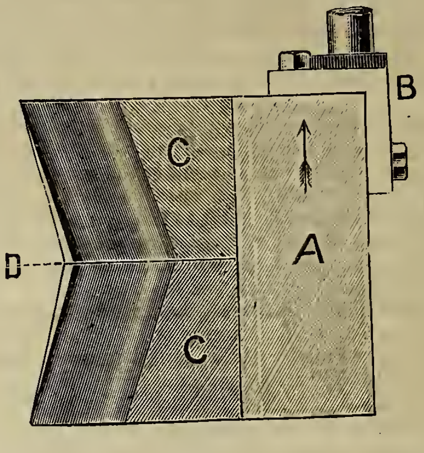

Fig. 1.

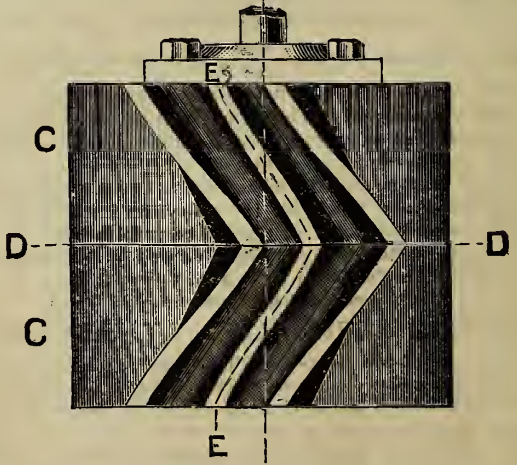

Fig. 2.

Since the odontograph scale of Professor Willis is based upon the cycloid curve, and is so close an approximation thereto that it is for all practical purposes absolutely correct, this scale is also applicable to the mechanical striking out of set gears of helical form, just as well as to those of common type. As my present subject is helical gears, and not wheel teeth in general, I must perforce assume that my readers are acquainted with the details of the practice of the application both of cycloid curves and of Willis's odontograph to the forms of wheel teeth, and go at once to the subject of the formation of helical wheels.

I am not aware that these wheels are made to any considerable extent from patterns. As a rule they certainly are not. But I have seen many hundreds of helical blocks, both spur and bevel, for use with wheel moulding machines. Hence my remarks will only have reference to tooth blocks made for machine use.

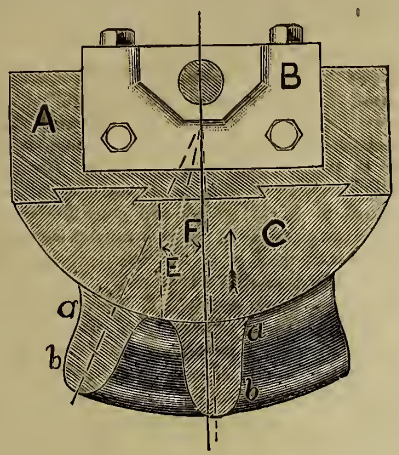

Fig. 3.

It is obvious that a helical block cannot be drawn perpendicularly from the sand like a spur or bevel wheel. Hence, except in the case of those machines provided with special apparatus for withdrawing the blocks at any angle, including the horizontal, there are only two courses open—either to withdraw horizontally by moving the main arm of the machine, which is a clumsy plan, though not unfrequently practised, or to joint the block in such a manner that it can be removed from the mould in detail. I have illustrated the construction of the latter method :

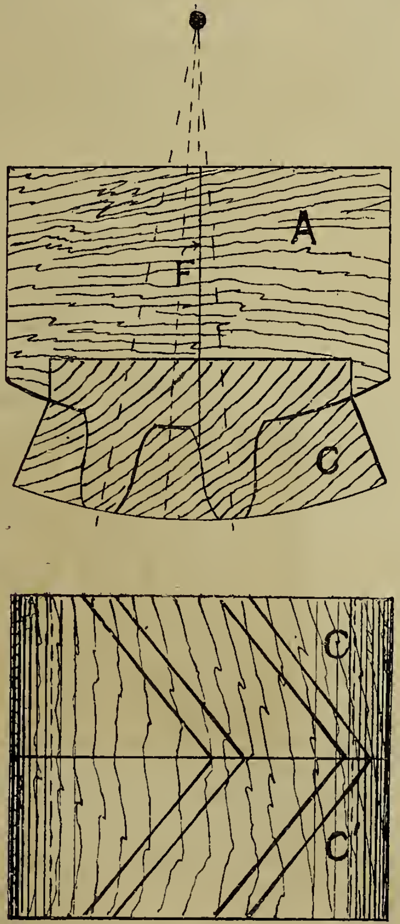

Fig. 4.

In fig. 3, A is a plain block, or backing, attached to the carrier B of the machine, with screws in the usual fashion. The teeth, instead of being attached directly to this, are either fastened to or cut in the solid with another block or blocks C C^1, dovetailed or otherwise attached to A. After ramming, the block A is lifted vertically, and C C^1 are then drawn back horizontally by the fingers of the moulder.

The methods of jointing C C^1 to A may differ. The teeth, with their backing, may be in one piece, but this is not usual. They are best divided along the middle plane D D (figs. 1 and 2), for convenience of striking out, of ramming up, and withdrawal. For the division thus gives a face for marking out the tooth curves precisely like those on the outer faces; also, at the time of ramming those portions of the teeth C^1 below the middle plane D, the portion C above that plane is removed to allow of the free action of the rammer in the diagonal direction, which would be interfered with if the upper piece C remained in place, and especially so in teeth of fine pitch and of high angle of obliquity. Also, it is easier to withdraw the top section C first and C^1 afterwards, than to take them away as one block.

A dotted line is seen at E. This indicates a necessary joint when the curvature of the block is of quick radius, that is, so much that the flanks of the teeth are undercut at *a a* in relation to *b b*. The block being then divided at E, each tooth is drawn singly without tearing away the sand.

These remarks embrace all methods of jointing blocks for spur wheels that ever occur. The method of preparation, marking, and working is as follows :—

First, the various blocks are prepared by gauging to thicknesses, checking the thicknesses with calipers, and jointing according to the requirements of the wheel in hand. The teeth are either in one with their immediate backing, as shown at fig. 4, or the block from which they are cut is fitted round the backing, as at fig. 3. In any case the longitudinal direction of the grain should coincide with that of the teeth. The former plan (fig. 4) would be adopted for small blocks, the latter (fig. 3) for large ones, where economy of mahogany is a consideration. The teeth ought to be made of mahogany, though pine will serve for the body and backing. If the teeth are fitted as at fig. 3, they are glued, allowed to set hard, and planed off flush with the top and bottom, and joint faces of the body pieces. Then the tooth forms are marked off on top and bottom and joint faces, as follows :—

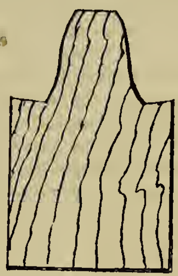

Fig. 5.

First, there is a centre line F (figs. 3 and 4) which is carried over both faces and down the back of the block. This is the line by which the block is adjusted and screwed to the carrier B of the machine, and this should occupy a central position in relation to the angle of the teeth, as is apparent in the face view in fig. 3. Then there are other central lines marked on top and bottom and in the joint, representing the centres of the inter-tooth spaces; and from these the teeth centres are pitched to right and left hand. Each of these centre lines (dotted in both figures on faces and in joint), must be *radial* from the centre of the wheel of which the block forms a segment, and their angular distance asunder must be determined by the conditions named in our previous article, that contact of one pair of teeth shall begin at about the instant contact ceases between the previous pair.

The illustration, fig. 4, represents the block at that precise stage when the curved peripheral portion which is coincident with the points of the teeth has been worked, and the helical twist of the termination of the tooth faces has been marked thereon. A word or two on this process will be appropriate. Whatever the curvature of the wheel may be, a diagonal line marked with a bent steel from joint face to joint face connecting the tooth profiles will be a helical curve. Every pattern-maker knows such to be the case when marking out a worm, or an elevator screw, or a small pile screw. The same, therefore, holds good of a helical wheel. Hence the face lines in fig. 4 are scribed along the edge of a blade of steel bent around the curvature. In a wheel of large diameter, especially if the teeth are shallow, there will be scarcely any twist perceptible; but in a small pinion, especially when the teeth are wide, the twist will be very marked.

Now, it is obvious that, having the tooth profiles marked upon the outer and upon the joint faces, and also the helical twist representing the tooth points on the curved periphery, the working out of the teeth by the aid of a templet, like fig. 5, is simply a matter of careful detail, and the teeth so worked will form short sections of true screws. The blocks are, of course, removed from their places for the purpose, and only gouges and chisels can be employed. It is usual, in order to facilitate the entry of these gears, to round the tooth points very slightly; and for purposes of strength, to work a hollow in the roots, as shown.

It is not essential that the mode of jointing the backing A with the main or tooth blocks C C^1 should be precisely like that seen in the fig. 3. Frequently a single broad dovetail is used in place of the two there shown; or a simple recess instead, in the face of A, flanked with parallel guides, as in fig. 4, receives the tooth blocks. But in any case it is essential that there be good fitting of slides, and perfect freedom of delivery one from the other. J. H.

THEORETICAL AND PRACTICAL EFFICIENCY OF STEAM AT HIGH PRESSURES.*

In dealing with questions concerning the efficiency of the steam engine, it is usual to include the history of the steam after it leaves the steam-engine cylinder. Inasmuch, however, as it is only that portion of its history which the steam spends in the cylinder up to the period of exhaust that admits of material modification, it is only that part which will now be considered.

The object of this paper is, firstly, to show that the Carnot theorem is limited in its application to steam-engine calculations of efficiency; and, secondly, to show that high-pressure steam must theoretically, as well as practically, be more efficient than low-pressure steam. For some time it has been increasingly evident that the behaviour of steam in a steam-engine cylinder cannot be interpreted by laws that are true for a permanent gas, and that the actual efficiency of its action is not proportional to the range of temperature used in the cylinder. It has, on the contrary, become evident that the practical efficiency is much more nearly inversely proportional to the range of temperature in the cylinder; and, moreover, it has become increasingly evident that the efficiency of the actual steam engine cannot be usefully measured by any standard based on the Carnot theory of the perfect engine, as expressed by the relation $E = \frac{T - t}{T}$. That is to say, the relation which the range of temperature bears to the absolute temperature is not an index of efficiency.

Modern practice has amply proved that the real efficiency of the steam engine has only been increased in proportion as the special character of the working fluid has been studied and provided for. The Carnot theorem ignores the nature of the working fluid, and the endeavour to realise with steam the conditions of a Carnot engine have led to delay in the development of the steam engine.

It has now been demonstrated, both experimentally and on the largest practical scale, that the most efficient working is obtained with steam when it is used so that the range of temperature in one cylinder is small. The expansive energy of steam at a high pressure can therefore only be utilised by expansion in several stages—that is to say, by passing it from one cylinder to another until the minimum working temperature or pressure is reached. The number of cylinders so required has been found to depend chiefly upon the maximum range of pressure economically permissible in each cylinder. By augmenting the number of stages of expansion, steam pressure has been usefully increased to about 180lb. per square inch, instead of about 75lb., which with the simple engine was found to give results little, if at all, inferior to those obtained with a higher pressure.

Formerly it was commonly assumed, chiefly as a deduction from Carnot's theorem, that there could be little gain as a result of the use of high-pressure steam, because the thermal value increased so slowly as compared with the increase in pressure. Upon the same grounds it is now generally held that the present state of our knowledge indicates that a pressure of about 200lb. will give results equal to those which are possible with any higher pressure. This argument is in strict accordance with the Carnot function already mentioned, and it is this argument which I propose to show is not necessarily a true one.

On the diagram, fig. 1, is a curve A B, which shows, according to Carnot's theorem, the ideal efficiency of the steam engine as a heat engine using steam at pressures of from 50lb. to 350lb. as marked along the abscissæ. From this it will be seen that the rate of increase of efficiency rapidly falls as the pressures increase. The temperature of steam, for instance, at 50lb. pressure absolute, being 281 deg., and taking 100 deg. as the lower temperature, or that of the steam engine condenser, the efficiency ratio $E = \frac{T - t}{T} = \frac{281 - 100}{281 + 460} = \frac{181}{741} = 0{\cdot}242$. At 100lb. $E = 0{\cdot}29$. This gives an ideal increase in efficiency of 0·048 for steam at 100lb. as compared with steam at 50lb. At 200lb. the efficiency ratio is 0·333, and at 250lb. E = 0·349. Thus the difference in the ideal efficiency as between 200lb. and 250lb. is only 0·016, so that according to Carnot the increase of efficiency attendant upon increasing the pressure of steam from 200 to 250 is $\frac{0{\cdot}048}{0{\cdot}016}$, or only one-third as much as for the 50lb. increase from 50lb. to 100lb. An increase in pressure from 300lb. to 350lb. gives an increase in efficiency measured in this way of only 0·01, or less than one-fourth that from 50lb. to 100lb. Thus, according to the Carnot theorem, the gain attending the use of pressures above about 150lb. could not, it has been assumed, be sufficient to counterbalance the practical disadvantages incurred. Experience has proved that this is the reverse of the truth. Every increase in pressure has secured an increase in actual efficiency which has been far more than is necessary to cover the increased cost of obtaining it. The rate of increase has been double that which the Carnot theorem indicates, and it has been amply shown that the engines made for and supplied with steam at a high pressure work under conditions which are much more nearly those required for maximum efficiency than do those engines which work with the lower pressure.

From the curve (see diagram) it will be seen that by raising the steam pressure from 65lb. to 150lb. the efficiency ought to be increased by 21 per cent, or that a saving of 17 per cent ought to be made. As a matter of fact, a saving of from 20 to more than 30 per cent has been achieved, or an increase in efficiency as measured on the Carnot diagram of from 25 to 43

Efficiency of Steam at High Pressures.

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
	Total Pressure.	Temperature T.	Difference in Temperatures △ T.	Volume. Cubic Feet.	Difference in Volumes. $\Delta V = V^1$.	Ratio of Expansion $\frac{V^1}{V} = R$.	Work Done During Expansion.	Efficiency $E = \frac{T - t}{T}$	Difference in Efficiencies $= \Delta E$.	Work Done by Expansion per 1° Fall in T.	$\frac{\text{Col. 7}}{\Delta H}$
1		281	46·8	8·354	3·98	1·91	49,280	0·242	0·048	1,053	3,460
2	100	327·8	30·5	4·377	1·389	1·46	28,000	0·290	0·025	918	2,998
3	150	358·3	23·3	2·988	0·706	1·33	19,454	0·315	0·018	835	2,714
4	200	381.5	19·5	2·282	0·429	1·25	15,080	0·333	0·016	773	2,605
5	250	401·0	16·0	1·853	0·288	1·20	12,240	0·349	0·013	765	2,458
6	300	417·0	15·0	1·565	0·210	1·16	10,372	0·362	0·010	691	2,930
7	350	432·0		1·35				0·372			

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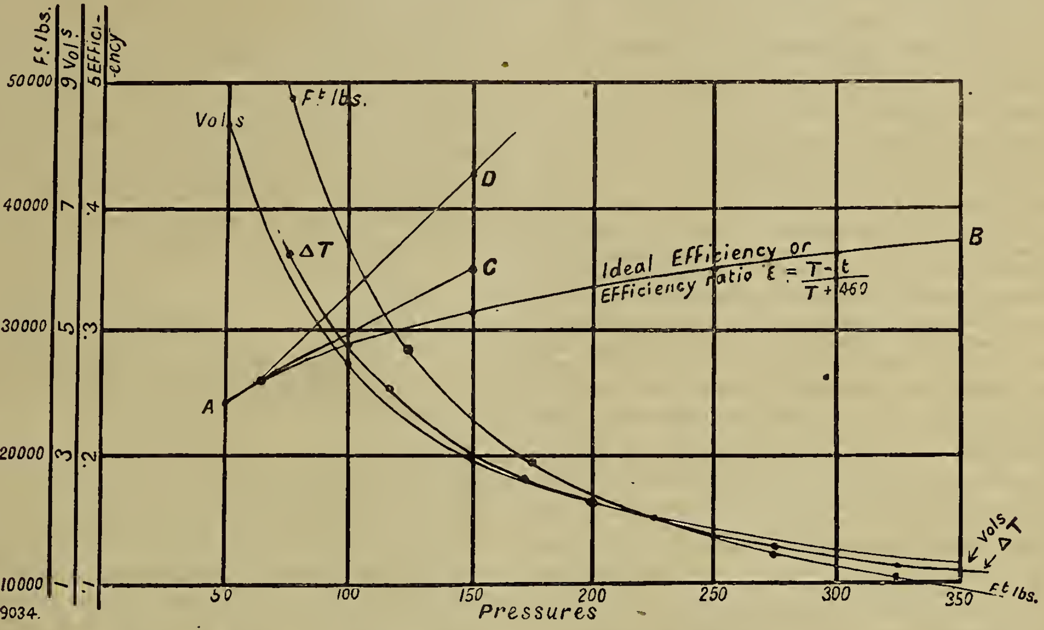
*Paper by W. Worby Beaumont, M. Inst. C.E., read before Section G of the British Association.

per cent. Taking 25 per cent economy, and for convenience of comparison starting from the Carnot curve at 65lb., the actual efficiency above that which is obtained when 65lb. of steam is used reaches 33 per cent, or the height shown by the point C. Taking 30 per cent as the saving, the relative actual efficiency reaches the point D.

It is clear, then, either that the high-pressure engine is remarkably efficient, or that the low-pressure simple engine is remarkably inefficient. No explanation has yet been given of the cause of the great difference; but it is the object of this paper to show that there are fundamental reasons for it, which have hitherto been overlooked. Steam can only be varied in the efficiency of its employment by variation of the conditions which affect the advantageous utilisation of its expansive energy. Now, as the total heat of a volume of steam, say 1lb., is within a few units as great after expansion as before it, nearly all the fall in the quantity of heat takes place when the steam leaves the steam-engine cylinder. To compare, then, the relative values of steam used expansively at low and at high pressures, it is desirable to examine the relative conditions of expansion through a given range of pressure before exhaust occurs, as, for instance, from 100lb. to 50lb., or 200lb. to 150lb.



9034.

A pound of steam at a pressure of 350lb. on the square inch and a temperature of 432 deg. Fahr., or 892 deg. absolute, has a volume of 1·35 cubic feet. A pound of steam at 300lb. and a temperature of 417 deg. Fahr.—877 deg. absolute—has a volume of 1,565 cubic feet. Assuming the pound of steam at 350lb. pressure to have expanded down to a pressure of 300lb., it will have fallen in temperature 15 deg. The mean pressure during the expansion from volume 1·35 to 1·565 will be 343lb., and this pressure, acting through the range of expansion of 0·215ft., represents 10,372 foot-pounds.[*] The work done by expansion per degree fall in temperature is thus 691 foot-pounds. Again, 1lb. of steam at 300lb., expanding from its volume of 1·565 to 1·853 and 250lb. pressure, falls in temperature 16 deg.; while the mean pressure during the fall will be 295lb., representing through the range of expansion 0·288ft.—12,235 foot-pounds—or 765 foot-pounds per degree fall in temperature.

Following the pressures, temperatures, and volumes, in the same way, of the pound of steam in expanding from 250lb. to 200lb., it appears that between these two the fall in temperature is 19·5 deg.; the expansion work represents 15,170 foot-pounds, or equal to 773 foot-pounds per degree fall in temperature. Between steam at 100lb. and at 50lb. there is a difference of temperature of 46·8 deg., and the work represented by the expansion of the steam from one volume to the other is 49,280 foot-pounds, so that the expansion work per degree fall in temperature is 1,053 foot-pounds. There is thus per degree fall in temperature of steam expanding from 350lb. and from 100lb. respectively a difference of 1,053 − 691 = 362 foot-pounds of work done. The expansion work done by steam between 100lb. and 50lb. pressure is then apparently $\frac{362}{691} = \cdot 52$, or 52 per cent greater per degree fall in temperature than with steam expanding from 350 to 300. These figures are given in column 12 of the appended table, and from them it can be readily seen how far is the departure from proportionality between the fall in temperature and work done during expansion.

Plotting a curve with the differences of temperature, Δ T, for ordinates, but increasing the value of the ordinates by a constant quantity so as to place the curve in a position for ready comparison with a curve of foot-pounds of work done by the expansion in volume, we have the curve marked Δ T.

In all cases, then, it will be seen that the quantity of work represented by expansion from one pressure to another at high pressures is more nearly that represented by fall in temperature or loss of heat than at low pressures. It will be seen, therefore' that if heat disappears in proportion to the work done, that the low-pressure engine cylinder, for a given range of pressure, must require more heat, either from a steam jacket, or from liquefied steam entering the cylinder during the admission part of the stroke, than the high-pressure cylinder.

These considerations help to show wherein lies the great advantages that arise from the use of high-pressure and multiple-stage expansion. With the exception of a very small quantity, a steam engine gives up in its exhaust steam nearly all the heat that the steam contained on entering.

By increasing the pressures used, an extra number of stages of expansion may be obtained at a small expenditure of heat in the boiler. The difference between the total heat of steam Δ H at 300lb. and at 250lb. is under 5 units, but the work done by expansion from 300lb. to 250lb. is about 12,240 foot-pounds, or about 2,400 foot-pounds per unit of heat employed in raising the pressure. The work done per unit of heat disappearing on expansion for each stage of 50lb. is given in column 11.

By adopting high pressures and short stages of expansion the arrival of the evil time of exhaust is delayed, and the method of delay is of the greatest importance. With a small range of expansion, not only is fall in the temperature on the working side of the piston kept down, but the temperature on the opposite side of the piston is kept up; so that the difference in temperature on the opposite sides of the piston is small. The new steam, in fact, expands in a warm cylinder kept warm under conditions which involve no loss.

The conclusions to which the foregoing leads, although this paper is only a preliminary consideration of the subject as put forth, are:

1. That the work done with steam in a steam-engine cylinder is not proportional to the range in temperature.

2. That steam pressures much above 200lb. on the square inch may be used with advantage.

3. That a small range of pressure should be used in each cylinder.

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[*] The volumes taken are those of saturated steam at the pressures given. Mean pressure between these has been assumed to follow a hyperbolic curve. This curve between two near points will be practically identical with the saturation curve, and the mean pressure given will not be inaccurate from this cause.

4. That the number of cylinders should be as large as mechanical considerations will allow.

5. That the economy obtained by multiple-stage expansion engines, as compared with single-stage expansion, is due to the small difference of temperature in a cylinder on the opposite sides of its pistons, to the opportunity which the protracted working history of the steam gives for the utilisable re-evaporation of the steam which is condensed in providing the difference, between the heat represented by work done during expansion, and the heat which corresponds to the change in volume, and to the large quantity of work during expansion at high pressures per unit of difference in the heat required to raise steam at a high or at a higher pressure.

ALLOYS: THEIR CONSTITUTION AND PROPERTIES.—V.

(Continued from page 585.)

It is now, I think, recognised that, except in the case of unstable forms of elements, the occurrence of elements in different allotropic states means that, in the respective cases, the atoms are differently arranged in the molecules of which the body is composed. I need not dwell upon these definitions here; all I want to insist upon is the great industrial importance of the change in the molecular conditions of metals and alloys, produced, as these changes are, by comparatively slight influences. It may help us to remember the importance of the subject if we bear in mind that the moral significance of allotropy, or rather of isomerism, has been recognised by one of the most subtle and refined writers of modern times, for the "Strange Case" related by Mr. R. L. Stevenson shows us what might happen if the same human being revealed alternately two entirely different natures and attributes. I have not hesitated to refer to this, because certain metals may, under slight influences, be made to assume forms in which, as regards special service required from them, they behave either usefully or entirely prejudicilly.

With regard to metals, chemists have, even to the present day, been very slow to examine the conditions under which a metal, when pure, can exhibit widely different properties—can pass from one allotropic state, as it is termed, to another. Berzelius claimed that the metals osmium and iridium could exist in different allotropic states; and in 1846 Joule and Lyon Playfair showed that certain metals in different allotropic states possessed different volumes; and although chemical analysis could detect no change in the composition of a particular metal in either of its different states, its properties were widely different. I have here several instances of this. In 1849, Bolley taught us to prepare lead in this form by electrolysis. It is as pure as this piece of sheet lead; but Bolley's lead oxidises rapidly in air, and becomes converted into a yellow powder, and sheet lead, we know, does not. Here is a form of copper which was first prepared in 1878 by Shützenberger; its specific gravity is less than that of ordinary copper; it oxidises rapidly in air; its behaviour in relation to nitric acid is different from that of ordinary copper; and last, it may be converted into ordinary copper by prolonged contact with dilute sulphuric acid. Similar cases of allotropism are claimed by Fritsche for tin, and for silver by Schützenberger. I have not specially alluded to Gore's antimony, or to modifications of nickel and palladium, because in their cases the passage from one state to another is determined by the presence or absence of occluded gas, and therefore the phenomenon becomes more complicated than when the composition of the metal is unchanged. It is quite true that in the cases I have referred to the variations in properties—the allotropy of the same element—are far less marked than the variations which characterise isomerism of organic compounds; but they are, nevertheless, very real and important, and if we knew the metals I have mentioned only in their unstable conditions, they would be unfit for industrial use. Imagine a vessel sheathed with Schützenberger's copper, or a cistern lined with Bolley's lead—disintegration and disaster would rapidly ensue in either case.

Fritsche found that certain ingots of tin, when exposed to the rigour of a Russian winter, fell into powder. This powder was certainly an allotropic form of tin; it was grey and needle-like, but by heating to a point far below its melting point it became changed into ordinary tin; and Fritsche points out that this property which tin possesses of passing into an unusual condition led on one occasion to some difficulty. A quantity of buttons, consisting mainly of tin, and intended for the adornment of military uniforms, were safely delivered by the manufacturer and placed in store. On inspection, however, by the military authorities, nothing but a shapeless mass of grey powder remained, for the tin had assumed its allotropic form, and the buttons disappeared. Specimens of such tin I have seen, but I regret that I have not been able to obtain a fragment.

We may now consider the question, Do metals, when they enter into union with each other, preserve their normal conditions, or do they in any case assume allotropic states? The experimental evidence that they do is somewhat difficult to obtain, but I will endeavour to set some facts before you.

Joule proved that when iron is released from its amalgam by distilling away the mercury, the metallic iron takes fire on exposure to air, and is therefore clearly different from ordinary iron, and is, in fact, an allotropic form of iron. Moissan has shown that similar effects are produced in the case of chromium and manganese, cobalt, and nickel, when released from their amalgams with mercury.

Evidence is not wanting of allotropy in metals released from solid alloys, as well as from fluid amalgams with mercury. Certain alloys may be viewed as solidified solutions, and when such bodies are treated with a suitable solvent, usually an acid, it often happens that one constituent metal is dissolved, and the other released in an insoluble form. Here is a new alloy of potassium and gold, containing about 10 per cent of the precious metal. If a fragment of this alloy be thrown upon water, the potassium takes fire, decomposes the water, and the gold is released as a black powder; there is a form of this black or dark brown gold which is, I believe, an allotropic modification of gold, as there is evidence that it combines with water to form auric hydride. By heating this dark gold to dull redness, it at once assumes the ordinary golden colour. The Japanese use this gold, released from gold-copper alloys, in a remarkable way (fig. 8), for they produce, by the aid of certain pickling solutions, a beautiful patina on copper which contains only 2 per cent of gold, while even a trace of the latter metal is sufficient to alter the tint of the patina.

Fig. 8.

The diagram represents a portion of a Japanese knife handle in the collection of Mr. Marcus B. Huish. It consists of *Shi-bu-ichi*, an alloy containing about equal parts of silver and copper The duck is of *Shakudo*, the alloy of copper with from 1 to 5 per cent of gold. By "pickling" a grey patina is given to the *Shibuichi*, and a purple patina to the *Shakudo* duck, the arrangement being so skilful that the neck of the duck appears to be beneath the water, and is only seen when the handle is held towards the light in certain directions.

The best illustration I know of the change produced in a metal by the action of mercury is afforded by the following experiment, for which I am indebted to Mr. Laurie, to whose work in another direction I referred in the last lecture. This plate of metallic aluminium would, as you know, long remain exposed to air without sensible oxidation. Mercury, also, does not oxidise at the ordinary temperature when exposed to air, but if the surface of this plate be covered with a layer of mercury, then oxidation rapidly ensues, and the plate will soon become covered with a white film of alumina, which may be detached in flakes. Clearly, the condition of the aluminium has been modified by its union with the mercury.

It will be remembered that in the last lecture it was seen that water could be frozen by the solution of finely divided fusible metal in mercury. It is not a matter of indifference whether the powders of the mixed constituents of the alloy are employed, or whether the alloy is previously prepared by fusion, and then powdered, which shows that the act of fusion has effected some change in the molecular arrangement of the metals; a point I am investigating, hitherto with somewhat conflicting results. The explanation of the depolymerisation of metals when they are united with each other is somewhat complicated, but I will attempt it with as much brevity as possible. First, Mazzetto has shown that there is a similar lowering of temperature, though to a far less extent, when molten tin is mixed with molten lead, so that the lowering of the temperature is by no means confined to the solution of metals in mercury. The next step we owe to Professor W. Spring, of Liége, whose results in building up alloys by compressing the powders of their constituent metals, as I showed you in the last lecture. Spring finds that by determining the amount of heat given out by alloys of lead and tin, on cooling from a molten state, that more heat is actually given out than might be expected from the results of calculation; the difference is so great that it could not be due to errors of observation, for in actual numbers it amounts to many hundreds of calories for a weight of 100 grammes. He concludes that when molten tin is added to molten lead, the atomic constitution of the molecules is simplified—that is, depolymerisation takes place. Let it be assumed that each molecule of molten lead contains an arbitrary number of atoms, say five atoms, and that the molecule of molten tin also contains five atoms. If one molecule of lead be added to three molecules of tin, so as to form the alloy $Pb\,Sn_3$, five groups of $Pb\,Sn_3$ will be the result, but each molecule of the alloy will contain four atoms instead of five, as this diagrammatic model shows. This molecular change, which I have effected by pulling the atoms asunder, requires heat to do the work of re-arrangement in the molten admixture of metals, and as this heat is absorbed cold is produced, and it will therefore be evident that both theory and experiment lead to the view of molecular change produced by alloying metals.

[The nature of the molecular change resulting in the absorption of heat which attends the admixture of molten lead and tin, and the evolution of heat which is observed when alloys of these metals solidify, was demonstrated to the audience by means of diagrams and models which it would be difficult to describe here. The reader is therefore referred to Professor Spring's paper, cited above. The subject is complicated by the possibility of chemical combination in the case of certain alloys such as $Pb\,Sn_3$.]

Debray has given us a case of an alloy in which a simple elevation of temperature induces allotropic change in the constituent metals. It is prepared as follows : Ninety-five parts of zinc are alloyed by fusion with five parts of rhodium, and the alloy is treated with hydrochloric acid, which dissolves away the bulk of the zinc, leaving a rich rhodium-zinc alloy, containing about 80 per cent of rhodium. When this alloy is heated in vacuo to a temperature of 400° C., a slight explosion takes place, but no gas is evolved, and the alloy is then insoluble in *aqua regia,* which dissolved it readily before the elevation of temperature caused it to change its state. We are thus presented with another undoubted case of isomerism in alloys, the unstable, soluble modification of the alloy being capable of passing into the insoluble form by a comparatively slight elevation of temperature. [Experiment shown.]

(To be continued.)

THE HARGREAVES THERMO-MOTOR.

At the last meeting of the Liverpool Polytechnic, the following paper on the Hargreaves Thermo-motor was communicated by the inventor.

The author said in a steam engine there were two great sources of loss : first, there was the loss in the boiler where the products of combustion were sent into the air at a high temperature, the heat necessary for which was all wasted ; secondly, there was the loss in the engine due to the latent heat being taken away by the condensing water. For these reasons only about 12 per cent of the total heat was utilised ; all the rest being thrown away. In the thermo-motor engine larger duty was obtained from the fuel by burning it in the cylinder itself, so that all, or nearly all, the heat generated by combustion was extracted from the fuel before it is rejected. Very high temperatures, he said, might be employed, and the higher the temperature the greater the efficiency.

The author then described the arrangement of the motor, commencing at the air pump used to compress the air. Water was injected into the air pump to reduce the temperature and, by vapourisation, to increase the pressure. The mixture of air and water vapour was then passed into a vessel called the saturator, where is was, if necessary, still further saturated with water vapour. After leaving the saturator the mixture of air and water passed into a vessel called the superheater, where it was heated by waste gases, and then through a regenerator filled with pieces of earthenware into the combustion chamber, where it met with a jet of liquid fuel and was burnt at a very high temperature, and consequently with great increase of volume and pressure.

The combustion chamber was lined with non-conducting material, so that the quantity of heat passing to the exterior walls of the combustion chamber might be regulated, and the interior of the chamber kept at a sufficiently high temperature to ensure perfect combustion of fuel. Attached to the top of the combustion chamber was a metal cylinder, within which worked the main piston.

The waste products of combustion passed out through the regenerator, giving up nearly all their heat (the temperature when leaving the generator being only about 350 deg. F.) ; they then passed through tubes in the superheater and saturator, giving up the remaining heat so thoroughly to a fresh supply of air and water vapour that the temperature of the escape pipe was only about 180 deg. F.

It was necessary, in order to maintain a tight joint, for the rubbing surfaces to be kept at a reasonable temperature. In a gas engine the cylinder was kept cool by a water jacket, and all the heat taken up by the jacket was lost.

The combustion chamber of the thermo-motor was jacketed much in the same manner, but it was made to generate steam so long as the inner surface of the combustion chamber was not cooled below a certain temperature. The water to supply the jacket was first taken through a hollow space in the piston, which it kept cool, and then into the jacket, where it was converted into steam. The jacket was in connection with a small supplementary boiler, which could be fired in the ordinary way when first starting, in order to get power to compress a supply of air for the main engine. The steam from the jacket, after passing through the small boiler, was led to the saturator, where it was injected into the mixture of air and water, until there was altogether about 30 per cent of water vapour mixed with the air. Air at a comparatively low temperature, containing that quantity of vapour, would not support combustion, but when the mixture was highly superheated, as it was in passing through the regenerator, it would burn. The mechanical arrangement of this engine might be of any convenient kind. As there seemed to be an impression that the engine was a very complicated one, the author wished to point out that it was not so complicated as an ordinary steam engine.

In answer to questions, the author said that about 20 per cent of the I.H.P. was used in driving the engine itself. For starting the engine a small portable furnace was used to heat the combustion chamber, and to compress a charge of air steam was got up in the small supplementary boiler which worked a donkey engine and air pump. For small engines a hand air pump might be used. The complete engine, as described, would be more economical than the simpler form, and he stated he could get 40 H.P. with a consumption of two gallons of creosote per hour.

The regulation of heat was to a certain extent automatic, for, when the temperature of the combustion increased, there was more steam generated in the jacket, which steam increased the proportion of water vapour in the air and so lowered the temperature of combustion. If too much steam was generated the temperature would be too low and more heat would be carried away, because all the heat of vapourisation could not be recovered. All the heat in the steam in a latent form was lost. It was more economical to use air, but if air alone was used the temperature became so high as to melt the whole interior of the engine. However, by making the non-conducting material of proper thickness, the engine became self-regulating by means of the difference in the generation of steam, which might become so large as to put the fire out if the non-conducting material were not properly proportioned.

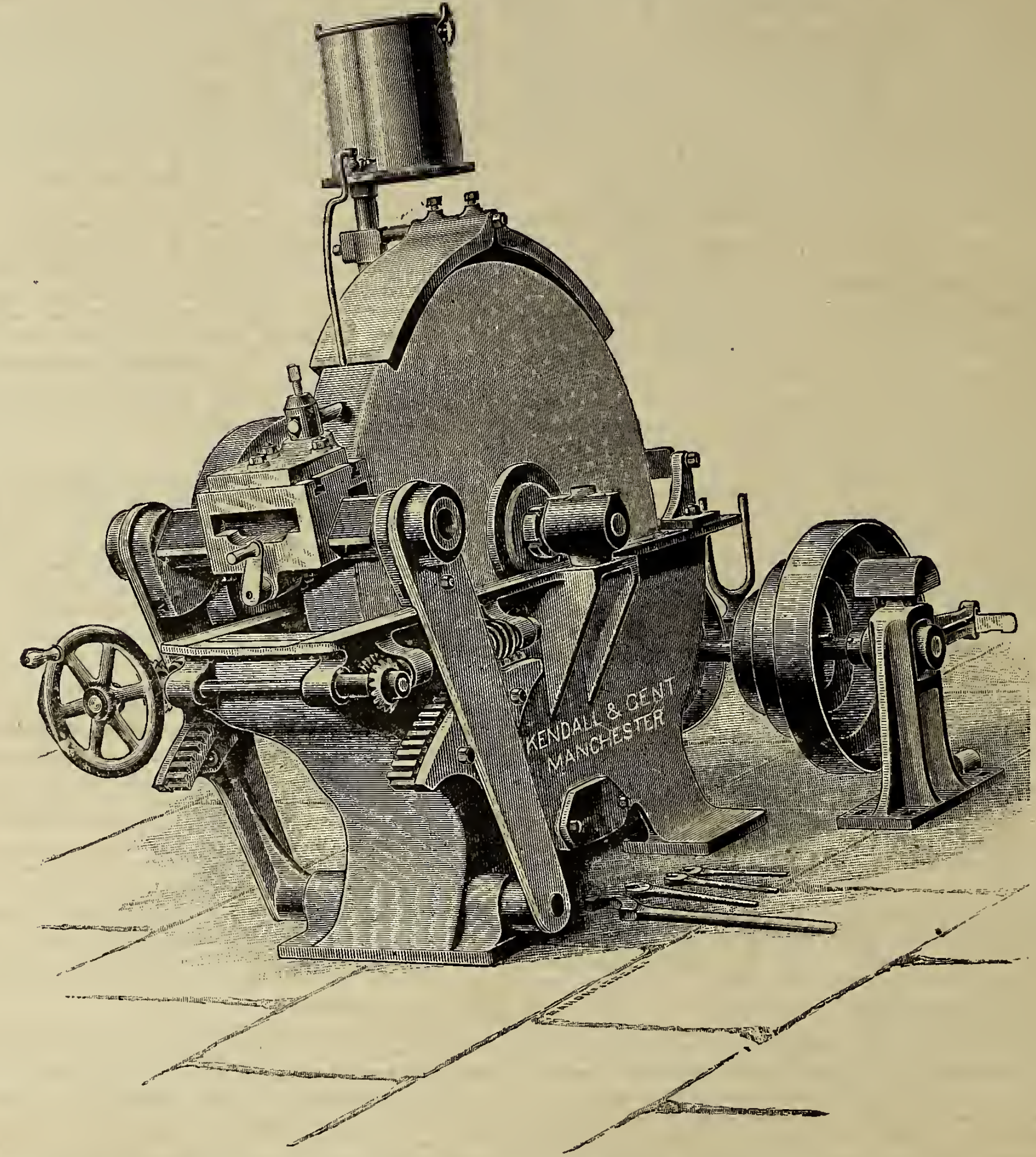
Professor Shaw, of University College, asked if he was not right in considering the principle of the engine was as follows :—Air was compressed in a pump and mixed with water spray, the resulting temperature of the mixture being about 160 deg. F. The mixture then passed through two vessels where it got further saturated with water vapour, then through the regenerator, taking up a large quantity of heat therefrom to the combustion chamber, where it met the fuel and was burnt, causing the single-acting piston to make a stroke ; on the return stroke of the piston the waste gases pass through the regenerator, leaving it at a temperature of about 400 deg. F., through tubes in the two saturating vessels, giving up therein nearly all the remaining heat to a fresh charge of air and water vapour, and finally passed away to the chimney.—Mr. Hargreaves said that was quite correct.

In reply to further questions, Mr. Hargreaves said he had not found anything better than china clay blocks for filling the regenerator, and good cast iron for the metal parts.

In reply to a further question by Professor Shaw, as to whether air could not be used for cooling the surfaces and then be utilised for mantaining combustion in cylinders by introducing it into the cylinder, not necessarily through the regenerator, the author did not think there would be any advantage in doing so. There was one thing he had not pointed out, and that was the advantage he got by mixing water spray with the air. It was a law that if liquid, at a certain temperature was exposed to air at the same temperature the vapour of the liquid added its own pressure to that of the air. For instance, if air was heated in a vessel from 32 deg. to 212 deg. F., the pressure would at first remain at 5lb., but by agitating or spraying the water so that its vapour could be absorbed by the air, the pressure would be increased to about 20lb. per square inch above the atmosphere. In that way heat was recovered that could not be possibly utilised by any other means.

RAWLINSON'S PATENT GRINDSTONE.

CONSTRUCTED BY MESSRS. KENDALL AND GENT, MANCHESTER.



There are few tools in an engineer's workshop better deserving attention than the grindstone, though it often happens that it is the one most generally neglected. The necessity for more exact workmanship, and the greater demands that are made with regard to the efficiency of cutting tools, has of late years caused more regard to be paid to this once much despised implement, and in the best shops the grindstone is now a machine equipped with a number of mechanical adjustments capable of a considerable amount of variation, so as to readily adapt it for the varied calls that are made upon its services.

The above illustration shows one of the most improved types of this machine, as constructed by Messrs. Kendall and Gent, of Manchester. It has been designed for the purpose of enabling the innumerable varieties of tools used in an engineer's shop to be ground with facility and precision. It is adapted for all kinds of tools, and is fitted with holders for different forms of cutters, so that an unskilled workman may readily grind the tools to any standard form.

One of the special features of this grindstone is that the slides which are usually placed on or near the top of the trough, and which soon become disorganised by the grit and water from the stone, are entirely dispensed with. The tool holder is mounted upon a rectangular transverse bar, which is furnished with an index at the side, so that the tool can be ground to any desired angle. The advantages of such a machine in a workshop where a large number of men are employed, whereby the various tools can be systematically ground by one labourer, instead of by each skilled workman separately, will be too obvious to need pointing out.

Messrs. Kendall and Gent manufacture several sizes of these machines, which are supplied with or without stone or top-driving apparatus, as may be desired.

THE INGHAM GAS PRODUCER.

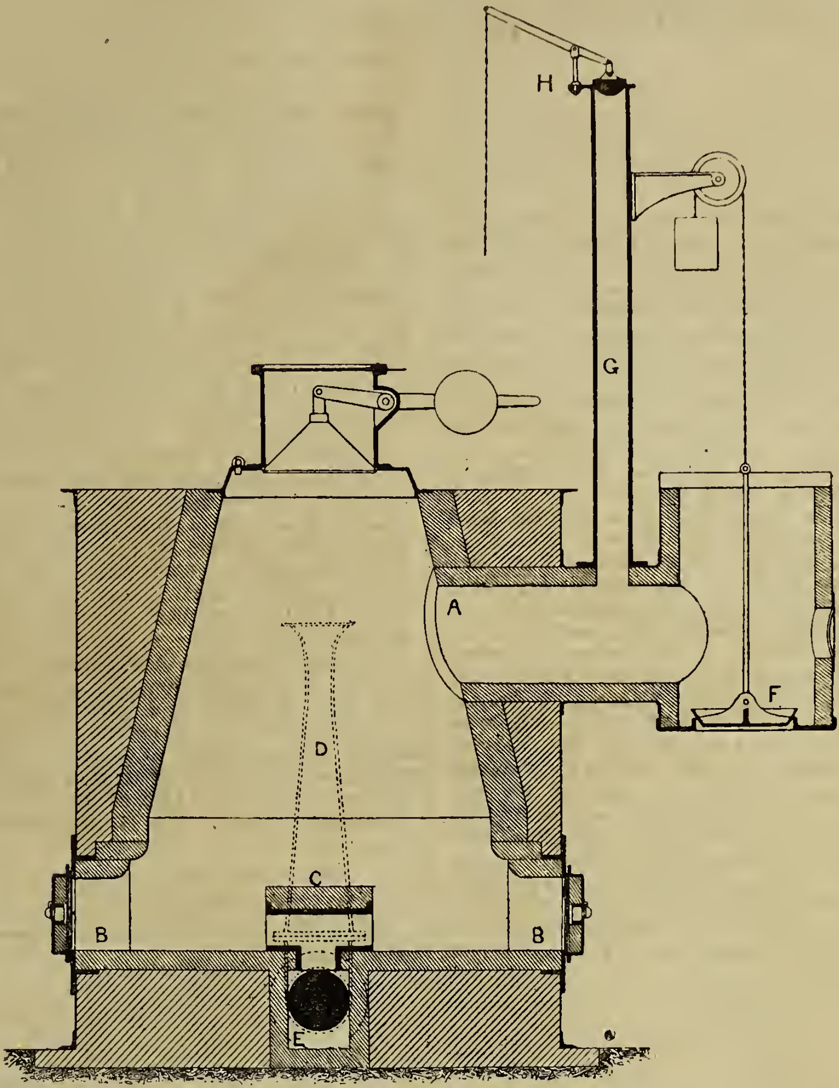
Recently we mentioned seeing one of the Ingham patent gas producers at work, supplying the furnaces for heating plates, angles, &c., at West Hartlepool; and as the producer has now been in use with satisfactory results during nearly the whole of the year, a description of it may not be without interest to our readers.

Like other gas producers, the Ingham consists of a wrought-iron casing lined with fire brick, and is charged at the top at intervals by means of the bell and hopper—the interior being kept full of fuel level with the gas outlet A (see illustration on page 617.)

The producer has been specially designed to facilitate the breaking up of the clinkers and clearing out the ashes, so as to keep the fire clean and open, and for that purpose cleaning out doors BB are placed exactly opposite each other, and at right angles with a central arch C, so allowing of a bar or rake being

THE INGHAM GAS PRODUCER.

(*For description see page 616.*)



passed right through the producer. The central bridge C also serves to relieve the weight of superincumbent fuel during the process of cleaning out. D is the steam and air jet for supplying the forced draught, the air for combustion being blown into the flue E at the bottom of the producer, then passing through the space under the arch C. The gas is taken off from the top under a slight pressure through the gas outlet A and the valve F, from which it is conveyed by means of piping or brickwork passages to the furnace or other appliances for which the gas is required. G is an outlet provided on the top with the valve H, which not only acts as a safety valve, but can also be utilised for illuminating purposes, by opening it and igniting the gas. This is an advantage when the producer is being operated during the night.

The Ingham gas producer we saw at work is 7ft. diameter and 8ft. 6in. high, and is designed to gasify 4cwt. of coal per hour. Messrs. Dorman, Long, and Co., of the Britannia and West Marsh Ironworks, Middlesbrough, have had six of these producers at work for some time, and at present are putting down as many more—while sixteen are at work at the West Hartlepool Steel and Iron Co.'s works, giving every satisfaction.

A Tall Chimney.—A chimney of unusual dimensions is at present being built at Freiberg for the purpose of reducing the smoke nuisance. Its height is 446ft., and there is, it is stated, only one higher chimney in Europe, viz., at Port Dundas, which is 454ft. The cost of the Freiberg chimney is about £6,000

INFLUENCE OF CHEMICAL COMPOSITION ON BESSEMER STEEL TIRES.

At the ordinary meeting of the Institution of Civil Engineers, held on Tuesday, the 4th inst., the president (Sir George B. Bruce) in the chair, a paper was read by Mr. J. Oliver Arnold, F.C.S., on "The Influence of Chemical Composition on the Strength of Bessemer Steel Tires."

The author observed that there was a growing tendency amongst engineers to specify for tires steel possessing a high resistance to tension. This was conducive to economy in wear; but it was doubtful whether such material was not more liable to sudden fracture than a more ductile, if less durable, steel. The chemical composition necessary to obtain high tensile strain, together with high elongation, was such as to render steel liable to molecular changes, which doubtless produced disastrous results. The author submitted the data upon which he based this conclusion. The question was rendered intricate by the fact that steel was a complex body, and that the influences of its elements upon each other, with reference to physical effect, had hitherto defied all attempts to reduce them to formulas; also by the difficulty of insuring in pieces of steel, identical in composition, a uniform and constant molecular structure. In addition to the iron, the percentage of chemical composition of normal tire steel was, approximately, carbon, 0·28; silicon, 0·07; manganese, 1·25; sulphur, 0·08; phosphorus, 0·08. A test piece, 2in. parallel and 0·564in. in diameter, 0·25in. area, planed out of a tire possessing the above analysis, would give on an average the following mechanical results, the figures being calculated on the original dimensions: Maximum tensile strain, 37½tons per square inch; elongation, 26 per cent; reduction of area, 47 per cent; and fracture, grey granular, with silky edges; shape, convex and concave. Such a tire, with an inside diameter of 2ft. 8in. and a sectional area of 11in., would behave under the falling weight test in a manner indicated by the subjoined figures, the weight of the tup being 22 cwt.:—

Fall in feet	2	4	6	8	10	12	Remarks.
Deflection in ins.	¼	¾	1¾	$3\frac{1}{16}$	$4\frac{11}{16}$	6½	Unbroken.

The falling weight test might have been continued until the tire was doubled up. Such a tire was adapted to fulfil all requirements, except that it wore out in time. It was little liable to molecular change under sudden heavy and repeated shocks. In Bessemer tire steel the carbon should lie between the limits of 0·25 and 0·32 per cent. High silicon in Bessemer steel was due either to underblowing, or to an impure manganiferous addition, and 0·2 per cent was a dangerous amount in a tire. High phosphorus was due to the use of originally impure pig iron, and 0·15 per cent was dangerous. High sulphur might be due either to impure pig irons or to inferior cupola coke. This element, though not so influential as silicon and phosphorus, should, nevertheless, be kept as low as possible. An abnormal proportion of silicon or of phosphorus in a tire produced brittleness. All three elements were impurities, to be kept low. Suppose that it was desired to increase the tensile strain of a normal tire 5 tons, that was to 42 tons per square inch, and at the same time to obtain without rupture the normal deflection of 2in. per foot of inside diameter, under the falling weight, such a result could not be safely obtained by an increase of carbon, because the additional percentage of this element would render the tire liable to break under the falling weight test before the necessary deflection had been obtained; therefore the manganese must be increased. Steel was made having the following composition per cent: Carbon, 0·25; silicon, 0·03; manganese, 1·75; sulphur, 0·12; phosphorus, 0·11. An ingot of this steel was hammered into a 4in. bloom; the bloom was then rolled down into a bar, 1¼in. square, from which four test pieces were turned, which yielded the following results: Mean maximum strain per square inch, 42·1 tons; mean elongation, 18·0 per cent; mean reduction of area, 26·3 per cent. The mean result of the tests on many tires practically identical in composition, 2ft. 8in. inside diameter, and having a sectional area of 11in., the weight of the tup being 22 cwt., was—

Fall in feet	2	4	6	8	10	12	14
Deflection in inches.	⅛	⅝	1⅜	$2\frac{3}{16}$	$3\frac{9}{16}$	5⅛	6¼

So far the conclusions to be drawn were that an increase of manganese produced an increase of hardness, whilst at the same time the tire was sufficiently tough under the impact of the falling weight. The addition of 0·5 per cent of manganese to the normal tire raised the strain supported from 37 to 42 tons per square inch, reduced the elongation from 26 to 18 per cent, decreased the reduction of area from 48 to 26 per cent, and required an additional 15½ foot-tons to produce equal deflection. The life of a tire possessing a tensible strain of 42 tons was longer than that of one breaking under tension at 37 tons per square inch; but the former steel was much more sensitive to the influences, rate of cooling, shocks, and vibration which converted steel from a tough substance, yielding under tension a grey granular fracture, to a brittle material presenting a fracture consisting of bright crystals. To obtain such a result as a breaking strain of nearly 50 tons the necessary percentage of manganese would be 2·5 per cent. No steel-maker would risk the inevitable brittleness of such a metallurgical deformity; therefore the aid of chromium had been invoked. It had been found that chromium, added in small quantities, raised the tensile strain of steel in a remarkable degree, without seriously diminishing the ductility; but that when added in a high proportion it induced brittleness. The analysis of tire steel required to stand a strain of at least 48 tons per square inch was carbon, 0·28 per cent; chromium, 0·42; manganese, 1·54; silicon, 0·08; sulphur, 0·10; phosphorus, 0·09. A test piece, prepared by hammering a 14in. square ingot down to 1¼in. square, was turned to 2in. parallel, 0·564in. diameter, and 0·25in. area, yielding the following results: Maximum tensile strain, 49·8 tons per square inch; elongation, 15 per cent; reduction of area, 26 per cent; fracture, flat and finely crystalline. A tire, 2ft. 8in. inside diameter, and of 11in. sectional area, behaved thus under a falling weight of 22 cwt.:—

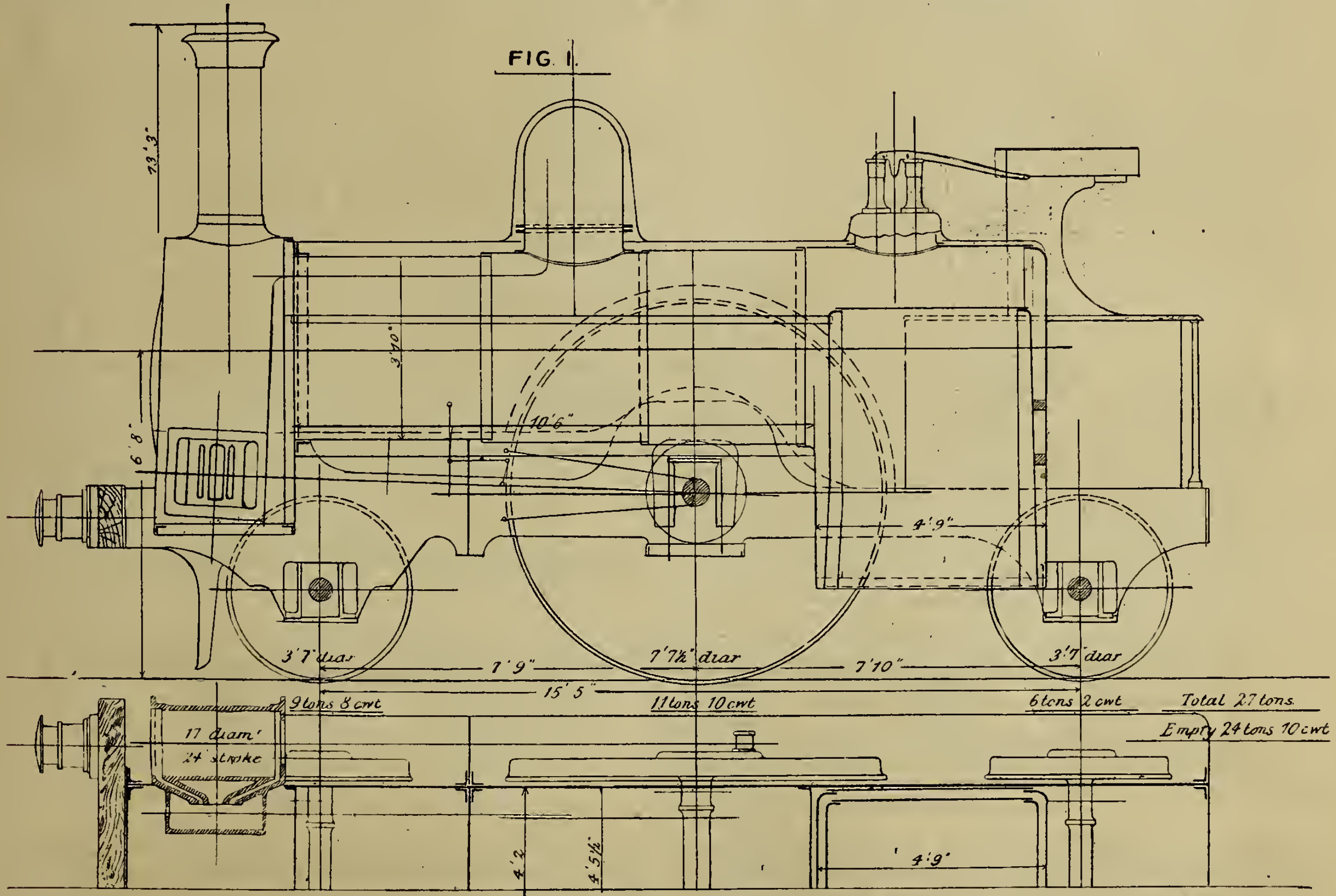
Fall in feet	2	4	6	8	10	12	14	16	18	20	25
Deflection in inches	⅛	½	1⅛	$1\frac{15}{16}$	$3\frac{1}{16}$	4⅜	5⅞	7⅝	9½	$11\frac{7}{16}$	Broke

A test piece, 2in. parallel, 0·564in. diameter, and 0·25in. area, planed out of the broken tire, gave the following results: Maximum strain, 47·7 tons per square inch; elongation, 3 per cent; reduction of area, 6·4 per cent; fracture, large crystals. The molecular change set up by the shock and vibration of the falling weight was thus indicated most clearly. Tires with a strain of 50 tons per square inch, together with great strength under the drop test, were very uncertain. The mean of four closely-agreeing tests, from pieces planed from various parts of the punished tire, of similar dimensions to the above, gave: Maximum strain, 46·2 tons per square inch; elongation, 20·7 per cent; reduction of area, 45·7 per cent; fracture, granular. Thus annealing raised the ductility of steel, and caused a molecular arrangement capable of great resistance to alteration under vibration and shocks. The influence of slow cooling, on the arrangement of the molecules into a form capable of resistance to rupture under shocks, was then indicated in a tabular form; also the liability of high-strain tires to assume a brittle crystalline structure, instead of the arrangement of interlaced molecules so conducive to ductility; and the loss of ductility resulting from the presence of too much chromium. The well-known fact, that the amount of work put upon steel had a marked relation to the molecular structure, and consequently to the ductility of the material, was then illustrated experimentally. Specifications were sometimes drawn up requiring a certain percentage of elongation, but failing to specify the length of the test piece to which such percentage referred. The effect of varying lengths and diameters of test pieces on the results obtained was exemplified in a series of trials. An ingot, 14in. square, was hammered down to a 4in. bloom. The bloom was then rolled into a bar 1¼in. square. From this bar twenty test pieces were turned. The results, summarised in tabular form, were:—

Length of Test Pieces.	Mean			Area per Square Inch	Mean	
	Strain.	Elongation.	Reduction of Area.		Strain.	Elongation.
Inches.	Tons.	Per cent.	Per cent.	Inch.	Tons.	Per cent.
2	43·4	22·2	36·1	0·25	43·8	17·0
4	42·8	20·2	34·3	0·50	43·7	17·7
6	43·8	16·4	35 6	0 75	41·7	19·2
8	42·3	16·2	37·4	—	—	—
10	44 1	13 2	31·4	—	—	—

The analysis of the steel bar from which the test pieces were turned indicated the following percentage composition: Carbon, 0·27; chromium, 0·26; manganese, 1·69; silicon, 0·04; sulphur, 0·12; phosphorus 0·11. From these tests the author inferred that so sensitive was high strain steel to physical change, that it was impossible to get even in one bar homogeneous molecular structure. Mean results showed that the length of a test piece did not affect the strain or reduction of area; that, if the elongation yielded by a 2in. test piece = 100 roughly, then that by a 6in. = 80, and by a 10in. = 60; that a test piece of large area gave a lower strain, and higher elongation, than one of small area. It was worthy of remark that the elongation obtained on a 2in. test piece, marked at eight equal intervals, in order to ascertain the distribution of the elongation, showed that this was less in those parts distant from lines of fracture. The engineer held that a certain resistance to rupture under a falling weight, together with certain results obtained on the tensile testing machine formed a criterion of the capacity of tires to meet strains when at work. This, though true in the majority of cases, has never been exhaustively proved. When the fracture of an axle or a tire led to some fatal disaster, the engineer was to some extent called before the bar of public opinion to account for the accident. In such cases, his explanation, that the breakage was due to an "original but invisible flaw," had become proverbial. An analysis and a tensile test of the broken article had been made, and the results obtained had thrown no light on the matter. But the important question with regard to the mechanical test arose—was the test piece planed from the immediate vicinity of the fracture? The author had obtained data which proved that injurious molecular change might be very local. Returning to the question as to how far the tests, to which tires were subjected before leaving the makers' works indicated their fitness to meet strains and vibrations, he suggested an investigation upon the following lines: At the works let tires be selected from groups, made from the same blows, each group being marked with a distinctive stamp. Let representative tires from each group be subjected to exhaustive chemicals and mechanical tests. Let the exact mechanical treatment from ingot to finished wheel be faithfully recorded. When the life of one of these tires was finished, either from breakage or in the natural course, let the chemical and the mechanical tests be repeated. Such a series of tests would indicate whether the influences encountered by a tire were such as to bring about molecular change. They would also show the chemical composition and the mechanical treatment most conducive to injurious molecular rearrangement, and those most likely to retain a permanently tough molecular structure. Finally, the author referred to the hardening of steel generally, and the effects of molecular changes of steel.

FIG. 1.



Heating Surface: Tubes, 1,013 sq. ft.; Box, 85 sq. ft.; Total, 1,098 sq. ft.; Grate Area, 15 sq. ft.

SOME TYPES OF THE MODERN LOCOMOTIVE.*

It has been truly said that a locomotive engine, followed by a train of carriages, especially when running at a high speed, always impresses the spectator as a remarkable exhibition of inanimate power. The association of compact, concentrated, mechanical action, with freedom and elegance of form, and with the most graceful of movements, complete an object of enduring admiration, and to some investigation of this admirable machine, in its latest development, its construction, its working, and its performance, within the limits of a short paper, my attention to-night will be directed.

The subject of the locomotive opens out such a wide and varied field for observation and argument, that I can only hope to touch on the fringe, as it were, of many important points in connection with it, and even with the restrictions imposed the subject is still too extensive to be adequately dealt with in one essay. I shall therefore, in dealing with "Types of the Modern Locomotive," confine myself in the first place to express engines, for the 4ft. 8½in. gauge, concluding with some few remarks on locomotives suitable for narrow gauges.

The speed of our express trains has during the last few years been steadily increasing, this being the result of the rivalry existing between our railway companies, which has reached its climax in what has been most appropriately named the race to the North. The interest which has been excited throughout the country by this race, added to the intrinsic merits of the engines themselves, claims priority for this class. Locomotives are now running intended to attain very high speeds with heavy trains, and those who have watched the development of the locomotive in size and power know that there is a growing desire for still higher speeds.

It is the opinion of many that our railway companies could if they liked easily increase the speed of their fast trains; as a matter of fact this is not so, as the engines as a rule are doing as much as they possibly can, and are so nicely and delicately timed that the slightest error of judgment on the part of the driver results in the train being late.

It might be thought that the addition of five or six miles an hour to the speed of some of our best trains would be a small matter; this is, however, just the last straw, and engines which without difficulty run at fifty miles an hour with a fair load cannot be persuaded to go faster by any possible means. The reason is not far to seek, and an example will, I think, make it plain. An engine which draws a train at say thirty miles an hour will exert a certain horse power. Now, if the speed be increased to sixty miles (and if we neglect the increased resistance at this increased speed), the horse power will have to be doubled; added to this, it is certain that the resistance per ton of load increases in a rapid ratio with the speed, but that this ratio is in no case constant. Thus we see, that neglecting the increased resistance due to the speed, in increasing from fifty to sixty miles an hour, 6 H.P. must be exerted where 5 before sufficed, which fact is often lost sight of. It is often said that the great speeds now being run on our railways are something quite new, and that the recent improvements in the locomotive have at last resulted in this whirlwind pace. Although this is no doubt to some extent true of the 4ft. 8½in. gauge, still large-wheeled locomotives were made and high speeds were obtained as far back as the year 1846, when Mr. Brunel and Sir Daniel (then Mr.) Gooch designed their type of engine, the Great Britain, for the 7ft. gauge, which made, I believe, one of if not *the* fastest journey on record, on May 11th, 1848, running from Paddington at 9-15 p.m. express to Didcot, 53¼ miles in 47min., an average speed of 68 miles an hour, the train consisting of the Great Britain, four carriages, and a van. This instance is, I believe, verified by official record. The dimensions of this powerful locomotive were: Cylinders, 18in. diam. by 24in. stroke; driving wheels, 8ft. diam.; grate area, 21 square feet; fire-box heating surface, 153 square feet; 305 tubes 2in. diam., the surface of the tubes being 1,799 square feet, and the total heating surface 1,952 square feet. The weight of the engine empty was 31 tons, and the weight loaded 41½ tons, it being capable of evaporating 300 cubic feet of water per hour, and was said to be capable of conveying a load of 243 tons at 40 miles per hour, and a load of 181 tons at 60 miles per hour.

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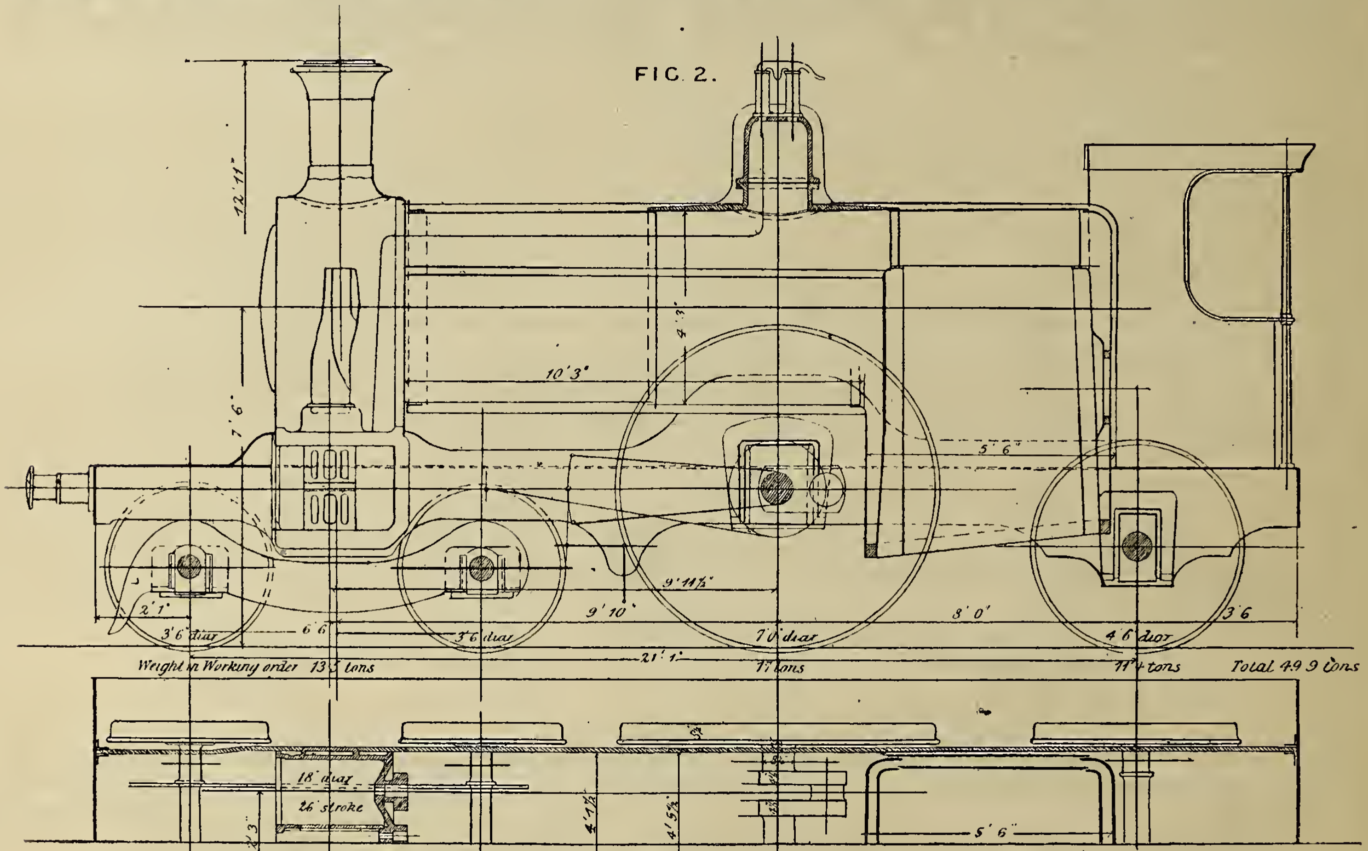
* Paper by Mr. James Bolas, read before the Manchester Association of Engineers, November 24th, 1888.

without full and authentic particulars of the gradients and loads throughout the runs, which particulars, I am sorry to say, I have not been enabled to obtain in a sufficiently complete state to justify an analysis of the performances. Still some particulars of the engines employed and the speeds obtained will, no doubt, be interesting.

Taking first the West Coast route, worked by the London and North-Western as far as Carlisle, and from thence to Edinburgh by the Caledonian: The train was composed of four eight-wheeled coaches, weighing 80 tons, including passengers and luggage, and on the first part of the journey, from Euston to Crewe, 158 miles, without a stop, the locomotive employed was one of the "Lady of the Lake" class, and the average speed 53·5 miles an hour. At Crewe the train was taken in hand by one of Mr. Webb's four-wheeled coupled engines, known as the "Precedent" class, this doing duty as far as Carlisle, 141½ miles, at an average running speed of 54·6 miles an hour. Considering the gradients against the train on Shap Fell, where we have 15 miles with an average of 1 in 120, 2 miles of 1 in 147, and 4½ miles of 1 in 75, this is a very fine performance indeed. From Carlisle to Edinburgh the Caledonian engine, designed by Mr. Drummond, was the motive power, the distance 100½ miles, and the average speed 55½ miles an hour; the road being against the engine to the extent of about 15 miles altogether of 1 in 200, 10 miles of 1 in 75, and 8 miles of 1 in 180. The total running time for the 400 miles was 442 minutes, or at an average speed of 54·3 miles an hour.

FIG. 2.



Heating Surface: Tubes, 973 sq. ft.; Box, 112 sq. ft.; Total, 1,085 sq. ft.; Grate Area, 17·4 sq. ft.

Besides the large driving wheels on the Great Western, the North Midland engines, made in 1838, had 6ft. driving-wheels, at that time the largest on the 4ft. 8½in. gauge; and although down to 1840 the working pressure in locomotives had seldom been increased beyond 50lb. per square inch, only a few engines working at 60lb., Mr. Wishaw says in his elaborate reports of his examination of the railway working of this period, "that high rates of speed were maintained, occasional instances of 50 miles an hour were to be met with, and several of the Grand Junction engines, both with and without trains, were sometimes permitted to descend the Whitmore and Madely inclines at a rate, for short distances, of 68 miles per hour." Although, as we see, fast times have been made over 40 years ago, we must bear in mind that these speeds were obtained either on a straight and level track, as from Paddington to Didcot, or down hill, and the merit in running at the speed which the Scotch expresses have maintained lies in the fact that they have much up-hill work to do.

In speaking of the race to the North, and the fast times that have been made, considering the inclines, a comparison of the work done on each road by each class of engine would have been instructive; at the same time the comparison would not be of use

Taking now the East Coast route, which is conducted on the Great Northern Railway as far as York, and forward to the Edinburgh terminus over the North-Eastern: From King's Cross to York Mr. Stirling's locomotive, with single drivers, had charge of the train, the distance being 188 miles, and the average speed 57 miles an hour. At York Mr. Worsdell's engine was coupled on, and conducted the train to Edinburgh, 204½ miles, at an average also of 57 miles an hour; the running time for the 392½ miles being thus at an average of 57 miles per hour.

In describing the locomotives that have taken part in this race, I shall commence, as in the runs, with the West Coast, taking the "Lady of the Lake" class first.

This locomotive, shown in fig. 1, was designed by Mr. Ramsbottom in the year 1863, being therefore 25 years old, and it reflects great credit on the designer that this engine should have been selected to compete with the latest designed locomotives.

The engine employed was the Waverley, which is rather more powerful than the others of its class, having 17in. diameter cylinders with 24in. stroke, against 16in. diameter by 24in. stroke.

The cylinders are outside the frames, coupled to single driving wheels 7ft. 7½in. diameter. The heating surface in the fire-box is 85 square feet, and in the tubes 1,013 square feet; the total being 1,098 square feet, with a grate area of 14·9 square feet. The total weight in working order is 27 tons, being in detail as follows:—

On the leading wheels	9 tons 8 cwt.
„ driving „	11 „ 10 „
„ trailing „	6 „ 2 „
Total	27 tons 0 cwt.

The tender weighs 17½ tons in full working order, and is fitted with Mr. Ramsbottom's water-picking-up apparatus, which accounts for its light weight, and proves the advantage to be gained in long runs by the application of this contrivance.

A comparison between the dead weight in the tender hauled by this engine and that on the Great Northern Railway is interesting. The Waverley, with a run of 158 miles without a stop—the weight of tender being 17½ tons; Mr. Stirling's 8ft. driver, with a run of 105 miles, the tender carrying 2,900 gallons of water—which will weigh 13 tons—and 5 tons of coal, the total weight being about 33½ tons.

This gives a gain to the Waverley of 16 tons—no small matter, considering that it has to be carried at a tremendous speed for 158 miles. That the Great Northern people recognise they are handicapped in this matter is proved by the fact that they contemplate adopting this apparatus on their fast trains.

To describe it in a few words. A hinged scoop is fixed under the tank bottom, passing through the bottom to a height above the water level, and suitable troughs are placed between the rails in places where it is known that the water supply will be nearly exhausted.

When it is necessary to replenish the supply of water in the tender, this scoop is let down, the speed of the train forcing the water up into the tank. The minimum speed at which this operation can be performed is 22 miles an hour.

Fig. 2 is a sectional elevation and half plan of the Caledonian express engine designed by Mr. Drummond, and is a fine example of the single driving wheel engine. Contrary to the usual practice when large single drivers are employed, the cylinders are between the frames, and are 18in. diam. and 26in. stroke. The driving wheels are 7ft. diam.; bogie wheels 3ft. 6in. diam.; and trailing wheels 4ft. 6in. diam.

The working pressure is 150lb. per square inch; the boiler having a total heating surface of 1,085 square feet, 973ft. being in the tubes, and 112ft. in the box, with a grate area of 17·4 square feet.

The weights on the rails when the engine is in full working order are:—

On the bogie	13·5 tons.
„ drivers	17·0 „
„ trailers	11·4 „
Total	41·9 tons.

(To be continued.)

CORRESPONDENCE.

We do not hold ourselves responsible for the opinions of our Correspondents.

COMPOUND LOCOMOTIVES.

To the Editor of "The Practical Engineer."

Sir,—The letter of "Practical Observer," in your issue of the 7th inst., proves the error of criticising from an imperfect account. He evidently did not hear my paper read, or he would not have fallen into the blunders that he has perpetrated in his letter; even with the account that he did read, it is almost inconceivable how anyone could make the number of mistakes that he does in the same space.

He first takes me to task in relation to piston speed, and says that "in nine cases out of ten the piston speed of a goods engine is as much, if not more, than a passenger engine." If "Practical Observer" had only studied with ordinary care the words he himself quoted he would find that I did not say passenger, but express locomotive.

I have before me as I write sets of indicator diagrams taken from Mr. Stroudley's "Gladstone" type express engine, which has cylinders 18¼in diameter × 26in. stroke, and driving wheels 6ft. 6in. diameter; and also from his class C. goods engine, with the same size cylinders, and 5ft diameter coupled wheels. The highest piston speed of the express is 1,258ft. per minute, and the highest piston speed of the class C. engine, cutting off at anything like ¾in. stroke, with a big load, and getting really useful work out of the steam, is about 400ft. And I would like to ask if "Practical Observer" knows of nine cases out of ten where goods engines are working at over, or even 700ft. of piston speed per minute, with heavy loads and, of course, a late cut-off? If he does, what is the amount of back pressure in those goods engine cylinders?

Then comes blunder No. 2. He says that if I rode on one of Mr. Worsdell's compounds I would find "that the passenger worked more expansively than the goods." Of course they do, which is just what I contended; and I must again refer him to the words he himself has quoted, when he will find that I said "that the express locomotive always worked with a high degree of expansion." Does "Practical Observer" know what that means? and that the goods locomotive (using more steam) was cutting-off at from half to three-quarter stroke. He also says that "there is less difficulty in getting rid of the exhaust in the compounds than in the non-compounds." Which I never denied, and, with marvellous obtuseness, he altogether misses the point I wished to enforce—which was that the express, working, as it must, very expansively (if we are to attain the high speeds contemplated), when non-compound, much economy in fuel can not be expected from compounding, while the goods engine, using much more steam at each stroke, and with, I repeat, a lower piston speed, a better chance for economy is offered.

In the next point, "Practical Observer," for a wonder, agrees with what I am reported to have said, viz., "That Mr. Worsdell's latest compound is the most powerful of its class in the world." This I did not say, the passage being faultily reported; although there is no doubt that it is one of the most powerful. This is not, however, due to its compound system, but because Mr. Worsdell has had the forethought when designing a locomotive intended to economise his steam to the greatest extent, to apply one of the best and largest boilers in heating surface and steam room on any English express engine. Now, "Practical Observer," does not this look significant; because anyone who knows anything at all about a locomotive knows that the boiler is the measure of its power.

If "Practical Observer" had had anything but an abstract before him he would not have fallen into his next blunder, in relation to the running of locomotives. And here again he quotes my very words, which were: "That we had no locomotives timed to run at 60 miles an hour." I did not say that 60 miles an hour had never been attained, and, in fact, gave in my paper instances where even higher speeds had been run many years before Mr. Worsdell's compounds were thought of. My contention was, and is, that we have not locomotives that are timed according to the table to run at that speed. Can "Practical Observer" point to any that run day by day, of course deducting any stops?

He triumphantly refers me to particulars of a special run made by Mr. Worsdell's compound from Newcastle to Edinburgh, and, strange to say, I had a similar report before me when I wrote the passage complained of. But will "Practical Observer" guarantee that these engines shall be timed by table to run at this speed? When reading the times quoted I set them aside, to be be taken with the proverbial grain of salt. For this reason a well designed English non-compound express engine burns about 3lb. of coal per I.H.P. per hour. Now the advocates of compounding claim a saving of from 15 to 20 per cent by its introduction. Giving them the maximum of 20 per cent, Mr. Worsdell's "compound" ought therefore to burn about 2·4lb. per I.H.P. per hour.

An example of "P. O.'s" accuracy occurs in his statement of the distances and speeds. He says that the run of 125 miles occupied 127 minutes, and the engine was delayed 4½ minutes, bringing the actual speed to 125 miles in 123½ minutes, instead of 122½ minutes. Cannot "P. O." subtract?

Taking these figures as about as near as I can get to what he means, 61·2 miles an hour was the average running speed. Now, I would point out to "P. O." that to run 125 miles in say 125 minutes is not nearly such a good performance as running 60 miles in 60 minutes. But in the case he quoted the greater merit would be due to Mr. Worsdell's engine's performance, as the trains had to be put through the operation of starting and stopping twice on account of the adverse signals. Now this great speed cannot be attained after starting in a few yards, so that a certain distance must be run at half speed, which will bring the average running speed up to about 65 miles an hour, and there is no doubt that at some parts of the journey 70 miles an hour must be reached, to account for slowing up inclines. Mr. Worsdell's compound weighs, in working order, 43 tons 6 cwt., and the engine and tender combined will weigh over 70 tons. Eight well filled coaches will weigh over 90 tons, which will make a total of about 160 tons. Let us say that an average weight of 150 tons is carried, allowing for the lightening of the tender. The resistance per ton of engine, tender, and train will no doubt be 40lb. per ton at 65 to 70 miles an hour; let us take, however, 35lb. as being the resistance, this time being no doubt done, if at all on a favourable day. These 150 tons at 35lb. will require 5,250lb. tractive force, and at an average speed of say 65 miles an hour = 5720ft. per minute $\frac{5720 \times 5250}{33,000} = 910$ I.H.P., and taking 2·4lb. coal per I.H.P. per hour, we should require to burn 2,184lb. of fuel on the grate in one hour, and as Mr. Worsdell's boiler has about 17·5 square foot of grate area, $\frac{2184}{17·5}$ = nearly 25lb. of fuel must be burnt per square foot of grate per hour.

Now, in this simple calculation I have stretched every point in favour of Mr. Worsdell's locomotive, so as to let "Practical Observer" down gently, and will he now say that this locomotive could be run timed to do this speed day after day for any lengthened period, and that it has not been doing about its utmost?

Other points I should have liked to dwell upon, but I refrain in consideration of your space and "P. O.'s" feelings. I have neither the time nor the inclination to enter into a wordy war with an anonymous writer, who only claims attention through his inaccuracy; but if your correspondent will furnish me with his name and address, I shall have great pleasure in sending him a copy of the paper so that some of my very "limited knowledge" of locomotives may tend to modify his unlimited credulity in matters or statements which appear in some of our professional publications.—I am, yours, &c., JAMES BOLAS.

Patricroft, Dec. 10th, 1888.

DIAMETER OF STEAM AND EXHAUST PIPES.

To the Editor of "The Practical Engineer."

SIR,—The diagram in your issue of the 1st inst. for obtaining the diameter of steam and exhaust pipes of steam engines is very useful, and opens out a question of vital importance that should be properly and completely understood by practical engineers. In my experience as iron and steel works' engineer I have met with non-condensing engines so cramped in the exhaust ports that the back pressure in the cylinder has been 7lb. (gauge pressure), and I know of engines now working the power of which would be doubled, or the working expenses reduced about 50 per cent, by putting on new cylinders with passages and pipes of the sizes given by your diagram. There is considerable evidence that this question is not thoroughly understood by steam-engine makers; 8,000ft. per minute in the main steam pipe, 10,000ft. per minute through the valve-port opening, and 6,000ft. per minute for exhaust are about right for the size of engine you give as an example. But for small engines these velocities must be reduced, and for larger engines they may be increased; and no definite rule or formula is applicable to all sizes and classes of engines. High-pressure steam must have a less velocity than low-pressure steam; a condensing engine will exhaust at a greater velocity than a non-condensing engine; and is it not a fact that piston valves require a less velocity of the steam than an ordinary slide valve? Valuable as your diagram is, its significant simplicity vanishes when the above conditions are taken into account.

I will leave small engines to those who have had better experience with them; but with regard to the breadth of port, I have found it under 0·5 of the cylinder diameter in many cases, and I consider 0·7 quite broad enough for any engine. If we take a port 6in. by 1in., we have 6in. in area, and considerable friction and loss of velocity; with a port 6in. by 2in., we have 12in. area, and less friction and a higher velocity is admissible. If reduced travel is desired, it should not be obtained by making the ports broad and short.

Engineers who know and understand this matter say very little about it, because what is quite right in one engine would not be right in another, but nothing will repay practical engineers better than a thorough discussion of this question. This can be done by comparing practical results with theory till the two are made to agree with each other.

I give the following result as one of some value. I have under my care a pair of 30in. engines, 3ft. stroke, running 100 revolutions per minute. The exhaust ports are 21in. by $2\frac{1}{2}$in = $52\frac{1}{2}$ sq. in. = say 0·365 sq. ft. Taking the area of cylinders as 5 sq. ft., we have $5 \times 3 \times 200 =$ 3,000 cubic ft. per minute, and $3{,}000 \div ·365 = 8{,}219$ as velocity of exhaust. The back pressure, by indicator cards, is from 1lb. to $1\frac{1}{2}$lb. Here we have proof that we can exhaust from this size and class of non-condensing engine at, say, 8,000ft. per minute without undue back pressure. At p. 534 of *The Practical Engineer*, dated December 2, 1888, we have proof that steam of 34lb. pressure will pass a slide valve port opening at 11,560ft. per minute without undue loss of pressure. Also a few remarks showing the advantage of a precise knowledge when dealing with engines of large size. Take, as an example, a pair of modern rolling mill engines, 42in. cylinders, 5ft. stroke, constructed for 75 revolutions per minute; the steam pipe area, with a velocity of 10,000ft. per minute $= \frac{1385 \times 750}{10000} = 103·875 = 21\frac{1}{2}$in. diameter. With a velocity of 12,000ft. steam pipe area $= \frac{1385 \times 750}{12000} = 86·5 = 10\frac{1}{2}$in. diameter, and say a 12in. main. This reduction in diameter of steam pipe does not seem much in itself, but when designing the valve and valve gear the diminution of opening from 103·875 to 86·5 is a very sensible one, that will make a very great reduction in the weight and magnitude of the valve, passages, and valve gear. Taking the smaller area of steam opening, and making the breadth of port ·7 of cylinder diameter = say 30in., then steam opening $= 86·5 \div 30 =$ say 3in., and make lap 3in. which cuts off at $\frac{3}{4}$ stroke and gives pleasant working over the centres, results in 12in. as travel of valve, a travel in excess of what some good workers allow.

The travel may be reduced to the requirement of the exhaust opening, but the lap will be reduced also, and the consumption of steam greatly increased. In this example the exhaust opening $= \frac{385 \times 750}{8000 \times 30} =$ say $4\frac{1}{2}$in., our steam opening being 3in., lap becomes $1\frac{1}{2}$in., and the travel is 9in., say $1\frac{3}{4}$in. lap and $9\frac{1}{2}$in. travel. This is about the average practice of good makers.

To reduce steam opening by valve to the practical minimum, we may avail ourselves of the aid given in Charles T. Porter's book on the indicator, and examine piston velocity and valve, opening at any or every degree of the crank's revolution until the point of cut-off by expansion valve or full steam opening is reached. By this method, a less steam opening than that resulting from the use of mean velocities of steam and piston will be found admissible in engines with early cut-off; then the necessary exhaust opening, minus steam opening, gives the maximum lap, and twice the exhaust opening is the least travel of valve.—Yours truly, R. T. COOKE.

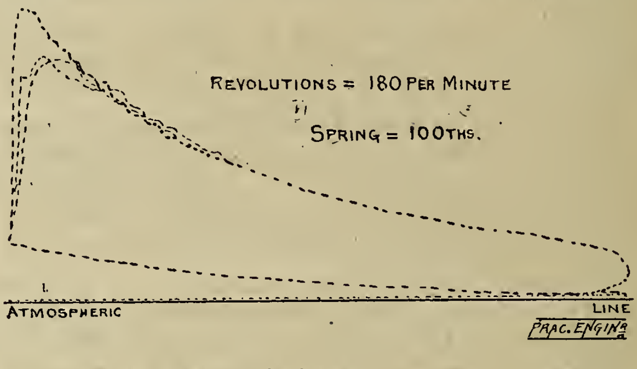
Dec. 4th, 1888.

HORSE POWER OF GAS ENGINES.

To the Editor of "The Practical Engineer."

SIR,—Allow me to point out some inaccuracies of a somewhat serious kind in the reply of "Draughtsman" in your issue of the 30th ult., in which he deals with the question of indicating gas engines; and as the statements appearing in a technical paper are largely relied on by scores of persons beyond the actual inquirer, allow me to point out where, in this instance, the errors occur. As personally acquainted with the manufacture of a well-known motor, I have had some years' practical experience in indicating gas engines.

The difficulty your writer, "Draughtsman," mentions exists only in theory. A gas engine can be, by anyone of experience, easily indicated with a fairly good instrument. It is true that the flame of explosion may shoot out if the indicator cock be opened, if the engine be at work, but it is not usual to do anything so unwise. It is no uncommon thing for us to have an indicator on an engine running full speed for half an hour or more together, but neither the indicator nor its stop-cock is more than just warm, and so far from the instrument becoming almost "red hot," it never, with anyone who knows his business, gets anything near as hot as if indicating a steam engine. The reason of this is simply that the indicator cock is screwed into a union not over $1\frac{1}{2}$in. long; below this a stop-cock screwed into the cylinder, or into a bend which is screwed into it.



The system of employing platinum wire gauze would seriously impair the action and indication of the instrument, but beyond this it is entirely unnecessary, and I can only say that we should never dream of in any way reducing the effective area of the passage way leading to the instrument. To the next misleading statement I must certainly say that by those who know, the Kenyon indicator is considered as not to be relied on. Its construction renders it manifestly unfit for sudden shocks or high pressures. After testing in every-day use all the well-known indicators, I may perhaps be supposed to know the faults. The Kenyon, with speed and pressure, we found utterly useless. The Thompson is well known to stick under the conditions of a gas engine, and the only two forms we know satisfactorily (and we are always open to practically test anything new) are the Richards indicator, with the Darkes motion, as made by Elliott Brothers, of London, and the improved Richards, made by Mr. Casartelli, of Manchester. Now the largest firm of gas engine makers in the kingdom, we were informed by Mr. Casartelli, use his make of improved Richards. My company use both that and the Elliott make.

The diagram you print plainly shows the defects due to the Kenyon indicator, defects so grave that I should greatly question the accuracy of its indications. As showing the difference between it and a diagram taken by an Elliott, I enclose for your inspection a card from one of our motors, which will plainly show in the rise of the pencil, as well as in the expansion line, the real difference of a suitable and an unsuitable indicator. With the complicated method he uses in calculating out the diagram I have not at the moment time to deal, but briefly to say the method he suggests is needlessly complex and lengthy. Trusting my remarks, which are based on many years' experience as a successful gas engine maker, may prevent readers being misled, allow me to subscribe myself, yours faithfully, A CIVIL ENGINEER.

QUERIES AND REPLIES.

VENTILATING FAN.—A fan gives 20,000 cubic feet of air per minute, going at 30 revolutions per minute, with a water gauge of ½in., what would be the increase in quantity if the fan was going at 60 revolutions per minute, and what would be the water gauge?

If a fan fixed on the upcast discharge 20,000 cubic feet per minute, going at 30 revolutions per minute, with ½in. water gauge, and a fan of the same diameter is put on the downcast, going at the same speed, what will be the increase in quantity of air, and what would be the indication of the water gauge? The fan on the downcast is forcing, and the fan on the upcast drawing.—J. W.

Answer.—If the fan be a positive acting one (as say the Root's blower), and the revolutions be increased to 60 per minute, the quantity of air passed through it in the same time will be sensibly doubled, and the column of water showing the difference of pressure will now be sensibly two inches, while the power required to drive the fan will now be quadrupled. If a fan fixed on the up-cast shaft discharge 20,000 cubic feet of air per minute while going at 30 revolutions per minute, with half-inch column of water as difference in pressure, and another similar and equal sized fan be now placed on the down-cast shaft and worked also at 30 revolutions per minute in aid of the other, the quantity of air passed through will be sensibly the same as before, but the power required by each fan will only be one-half of that required to drive each fan if worked separately, and the water column measuring the difference in pressures adjoining each fan will be each sensibly quarter-inch, one being in tension and the other in compression.—W. A.

CHANGING CURRENTS IN DYNAMO.—I have a series of wound dynamo of the old Gramme type under my charge, working 19 large arc lamps, and I have found lately that both carbons have craters in the ends, showing that the current must have flowed alternately; and, if this be so, the polarity of the machine must have been constantly changing. Can any reader tell me whether this is a common thing or not, and if there is any remedy for it?—T. H.

PITCH STRIKER FOR SCREWS.—Will someone be kind enough to favour me with instructions for making a "pitch striker," or where the tool can be bought? The use of the tool is to obtain, with certainty, a true thread by the ordinary hand chaser.—A FITTER.

RE-CUTTING AND TEMPERING TAPS AND DIES.—I should be much obliged if any reader would give me a little information as to the process of softening, re-cutting, and tempering taps and dies.—BOLTMAKER.

BLACKLEAD PENCIL MAKING MACHINERY.—Can any reader inform me where to obtain the raw plumbago for making ordinary blacklead pencils, also the mode of manufacturing same, and the name of any makers of pencil machinery?—B. B.

ELECTRICITY.—I have a slight knowledge of electricity, and should be glad if some of your numerous readers would kindly tell me the best work to study in order to extend my knowledge. I should like one to start from the very beginning and lead up to the various formulæ for leads, dynamo, accumulators, &c., and hints for fitting up installations and management of same.—J. P. W.

VARNISH FOR PAPIER-MACHÉ GOODS.—Would some reader kindly inform me how to make the black varnish that papier-maché goods are coated with? I want it so that it will not peel off the card. How is the glaze put on after the goods are varnished?—J. T. L.

SLIDE VALVE OF HYDRAULIC ENGINE.—Will some reader kindly inform me which is the best form of slide valve to adopt? The engine makes 20 strokes per minute, and the pressure is 1,000lb. per square inch. I should be glad also to learn what kind of stop valve is generally used for hydraulic cranes.

TO CORRESPONDENTS.

AMATEUR MECHANIC.—We don't see that you ought to experience much difficulty in keeping any pressure you please between the discs. Why not prolong the casing within which they revolve, and fit the casing with flat ends, like the ends of an engine cylinder; then furnish the shafts on which the discs revolve with a stuffing box and gland similar to those applied to the piston rod of a steam engine.

JOHN WOOD.—We are obliged for your suggestion with regard to drawing of hull of steam launch to make the series of working drawings of launch engines complete, and have arranged for the drawing of same to be prepared. It will appear in our pages in due course.

R. L. E.—The inspector will not put a hard and fast list of questions to you. Any inquiries he makes, we do not doubt you will be able to answer readily enough. His only object in speaking to you will be to obtain information on points that he cannot ascertain from personal inspection.

WORTHINGTON PUMP.—Will you or some of your readers tell me why each cylinder of a Worthington type of pump has five ports (including exhaust)? How are the valves set with reference to levers? A diagram would oblige.—RE.

VALVE GEAR.—We are not aware that an employer has any lien whatever over a patent taken out by one of his servants, even if that servant be an apprentice, and therefore do not think you would find it necessary to have a trustee to sign for you. The only way in which you could satisfactorily test the reversibility of the engine would be by taking off the valve chest cover, and carefully examining the position of the valves as the engine was turned round on its centres. Of course, the question can be answered in a practical way by an examination of the indicator diagrams, but to measure it with mathematical precision would necessitate the adoption of the course described. With regard to valve gears, Zeuner's book gives a very exhaustive analysis of the theory of valve gears. We may also mention Rigg's book on the "Steam Engine," while a most excellent treatise is that by Joshua Rose, M.E., published by Sampson, Low and Co.

W. A.—"Janey" begs to convey his thanks for "W. A.'s" answer to his question *re* specific gravity of sea water.

ARGOSY.—You will find a very full answer to your query in the reply to "Marine Engineer," given on page 467 of our issue for September 28th, though we may just supplement this by saying that the subject of Board of Trade Examinations will be dealt with in an article which will appear in the course of a week or two, in continuation of the series entitled "An Engineer's Life at Sea."

APPRENTICE.—There are no special openings reserved for those who obtain Whitworth Scholarships on the expiration of their studies, and indeed in the majority of cases it is then that the real struggle, from a professional point of view, begins.

FIREMAN.—We presume what you want is a sectional view of Gresham's patent injector. We have not a circular by us, but no doubt if you will communicate with the makers they will supply you with one. The address of the firm is Messrs. Gresham and Craven, Craven Ironworks, Ordsall Lane, Salford, Manchester.

H. H.—We are not aware that the lecture referred to has been reported, but if you would communicate with the secretary of the association, Mr. Jno. McGregor, 13, Davidson Street, Bridgeton, Glasgow, he would no doubt supply you with every information.

H. M.—The bursting pressure of the cylinder will depend, of course, upon the ultimate tenacity of the iron Taking this at, say 5 tons per square inch, then the bursting pressure P in pounds per square inch would be, for a cylinder 12in. diameter, $P = \frac{5 \times 2240 \times 2 \times \text{thickness}}{12}$ With regard to your third query, we may say that a theoretical calculation of the strength of such a structure would be not only complex but also unreliable, on account of the uncertainty as to the initial strains set upon the casting in the first instance. The strength in such cases is generally determined by practical experience. Your second query we have given in another column.

MATHEMATICS.—There are so many good elementary treatises on algebra that it is difficult to say which would suit you best. Your best plan would be to apply at the booksellers for one or two samples; you could then choose for yourself.

MISCELLANEA.

THE LARGEST TELESCOPE.—Another large telescope, dwarfing the instrument in Lick Observatory, is proposed by the University of Southern California. Perhaps in co-operation with Harvard University, a glass will be made 42 inches in diameter, as compared with 34 inches, the size of the Lick Observatory glass, and the effect will be to bring the moon within 60 miles of the earth, as it would appear if viewed by the naked eye. Mr. Clark, the well-known American optician, estimates the cost of the glass and the mounting at £100,000.

VALUE OF THE WORLD'S RAILWAYS.—The railroads of the world are estimated to be worth from twenty-five to thirty thousand million dollars. This probably represents one-tenth of the total wealth of civilised nations, and one-quarter, if not one-third, of their invested capital. It is doubtful whether the aggregate plant used in all manufacturing industries can equal it in value. The capital engaged in banking is but a trifle beside it. The world's whole stock of money of every kind—gold, silver, and paper—would purchase only a third of its railroads.

A LARGE GEM.—A large block of agatised wood is on view in Broadway, New York. It is of great size, weighs 4,200lb., and measures 4½in. by 33in., and is 34in. high. It came from the petrified forests at Chalcedony Park, Arizona, near Corriza, Other pieces of the petrified wood have been brought from these forests, but none which approached this specimen in size. The wood is used for making table tops and handsome wood ornamentation. The polished surface shows a beautiful blending of yellow and black, and in some respects resembles the red wood of the big Californian trees.

NEW STEAMSHIPS FOR THE PENINSULAR AND ORIENTAL COMPANY.—A fresh addition has been made to the fleet of the Peninsular and Oriental Company. The Peninsular, one of the two new mail steamers building at the yards of Messrs. Caird and Co., at Greenock, made her trial trip a few days ago. This vessel is 440ft. long and 48ft. beam, with a gross register tonnage of 5,000, and is intended to accommodate 155 first and 50 second saloon passengers. She has eight watertight compartments, with ample supply of lifeboats, with patent disengaging gear. This specimen of naval architecture is destined to reinforce the company's India and China mail service, and her first voyage will be to Bombay direct, leaving London on December 7th.

BOILER INSURANCE AND STEAM POWER CO., MANCHESTER.—An interesting meeting of the inspectors of the above company was held on Saturday last, at the Grosvenor Hotel, Manchester, for the purpose of congratulating Mr. J. F. L. Crosland, M.Inst.M.E., on his recent promotion to the position of chief engineer to the company. During the evening a handsome timepiece was presented to Mr. Crosland as a mark of their regard, and as a slight token of the kind advice and assistance they had received from him during the many years he had acted as assistant engineer. Between 60 and 70 inspectors took part in the proceedings, which were throughout enjoyable and enthusiastic.

A NEW SUBMARINE BOAT.—It is said that the French Government, have just given an order to the Campagnie Générale des Bateaux Parisiens for the construction of a new submarine boat, which is to be used for defensive rather than an offensive purpose, its object being the destruction of submarine mines, and thus preparing the way for the main vessels of a fleet. Like all submarine boats, it is said to be cigar-shaped, and is to be made of steel plates 0·16in. thick. Its total length will be 14·95ft. only, and its diameter 5ft. 4in. Its crew will consist of two men, who will be provided with air by stores of compressed oxygen, permitting a stay of several hours beneath the surface. The boat will be propelled by a screw driven by an Edison motor, the current to which is to be supplied by a Schanschieff primary battery. The interior is to be lighted with five 8-candle power and incandescent lamps, and an arc light projector is also to be fitted.

Extraordinary Electrical Storm.—The Guion liner Alaska, from New York, which arrived at Queenstown a few days ago, brought intelligence of the ship Edward, from Havre, with a cargo of iron ore, whose captain reported that the vessel encountered a terrible electrical storm in the Atlantic on the night of the 31st of October, when in latitude 41·42 north, longitude 54·42 west. The storm lasted for several hours, during which time the vessel was continuously enveloped in lightning. Eleven seamen were prostrated on deck, and deprived of sight for nearly half a day, while the second officer and boatswain were also dashed to the deck and received serious injury, the former being rendered speechless for five hours. Three balls of fire exploded with a tremendous report over the main rigging, scattering flaming fragments over the ship, driving the remaining members of the crew in terror into the forcastle. From three a.m. until seven p.m. the captain and mate were the only persons aboard capable of doing any work, and on them devolved the task of keeping the vessel before the easterly gale. The captain states that the electrical storm was the most terrible he ever witnessed, and thinks that its severity was in great measure due to the iron ore with which the Edward was laden.

The Proposed Sheffield Ship Canal.—The following particulars of the proposed ship canal from Sheffield to the sea are taken from the plans which have been deposited by the promoters, in accordance with the Standing Orders of Parliament. Commencing at the Sheffield end of the scheme, it is proposed to take seventy acres of vacant land, mostly belonging to the Duke of Norfolk, near Brightside Lane, and there to construct a dock twenty acres in extent, with quays and all other buildings and appliances necessary to the loading and unloading of vessels. The docks will be close to the principal works where heavy goods are produced. From thence, a new and shorter cut will be made through Carbrook, where a considerable quantity of cottage property will be swept away, and on to Tinsley, where it will join the existing canal. Thence it will pass through Rotherham, Mexborough, Swinton, Doncaster, and other populous towns, following the course of the canal belonging to the River Don Navigation Company, and on to Stainforth. At a point near to the Keadby railway junction, the canal will join the Stainforth and Keadby canal, and go on to the river Trent and Keadby, where the river is navigable. It is proposed to make the canal 80ft. in width by 15ft. in depth.

Long-distance Telephoning.—A telephone service has recently been opened between Philadelphia and Portland, Maine, a distance of 450 miles, and is stated to be working satisfactorily. Philadelphia, New York, Brooklyn, Albany, New Haven, Hartford, Providence, Boston, and Portland, with intermediate towns, are now in telephonic communication, covering a territory represented by seven States, whilst a line between Buffalo and Albany, including the cities of Syracuse, Rochester, Utica, Albany, &c., has also been opened. There are at the present time over a hundred manufacturing establishments in the territory adjacent to New York which are daily patrons of this system, either by leasing lines or by contracting for so many hours per day, and these companies are all suppled with the improved long-distance transmitter—the invention which, with the use of hard-drawn copper conductors, made possible this advance in the telephonic industry. The extension of this system to Cleveland, Pittsburg, Baltimore, Washington, Cincinnati, and Chicago is now only a question of time, as it is known to be electrically possible. The telephone services have been constructed by the American Telephone and Telegraph Company of New York.—*Iron.*

The Lawrence Gas Economiser.—Another new gas process may now be added to the increasing list of those which have recently been brought before the public. The object of the present invention is to enrich and economise ordinary coal gas, which it appears to do very effectually. The apparatus employed consists of a metallic sealed chamber, in which a number of trays are placed one above the other. In these trays, gasoline, absorbed into shavings as a carrier, is placed. The ordinary gas from the meter is admitted at the bottom of the chamber, and passes backwards and forwards from side to side of the economiser over each of the trays in succession, absorbing the gasoline on its way upwards. Before reaching the top of the chamber, the enriched gas encounters and passes through a perforated plate, which deprives it of any gasoline that it may contain in a vesicular form. The gas then passes out at the exit, and is led to the burners through pipes in the usual way. It is stated that 4½ gallons of gasoline will carburate 1,000 cubic feet of coal gas, and that no condensation or deposit whatever takes place in the pipes. It will be seen that the gas is enriched just as it is required for use, and that it is not stored after treatment. The practical results of an extended series of experiments, it is said, go to show that the production of an equivalent illuminating power by the apparatus is obtained with a consumption of less than a third of the quantity of city gas necessary to give the same candle power when used without carburation. A demonstration was given a few days ago with the apparatus by the Lawrence Automatic Gas Company, of 58, Lombard Street, London. Ordinary city gas was burnt in a Bray No. 6 burner, consuming 10ft. per hour. Lawrence gas was burnt in a Bray No. 0 burner, consuming 2ft. per hour, 2·2ft. being the actual quantity registered, the flame in the latter being fully equal, if not superior, to that in the former burner. The new gas is already in use in several instances in London and the provinces.

SELECTED PATENTS.

APPLICATIONS FOR LETTERS PATENT.

November 26th.

17144 Metallic Packing, S. Banner, Sunderland.
17148 Feed-water Heaters, J. Shaw and R. Alexander, Newcastle-on-Tyne.
17156 Automatic Condenser, J. Whittle, Manchester.—[Complete Specification.]
17167 Gas Engines, E. Körting, London.
17168 Steam Vessels, E. J. Agar, Eastham.
17174 Hoists, H. C. Walker and R. F. Carey, London.
17178 Electric Motors, W. M. Mordey, London.
17189 Crushing Machines, C. K. Mills, Middlesex. (C. Morel, France.)

November 27th.

17204 Regulation Jet, H. A. Price and H. C. Turner, London.—[Complete Specification.]
17206 Self-adjusting Bearings, J. A. Freeman and D. Donald, Penrhyn.
17216 Compound Steam Engines, E. B. Benham, United States.—[Complete Specification.]
17229 Holding Screw Taps, H. H. Lake, London. (S. D. Leland, G. S. Lewis, and F. E. Fay, United States.)—[Complete Specification.]
17232 Fasteners, T. J. Carr, Barnsley.
17239 Horizontal Grinding Mills, F. W. Follows, Manchester.
17240 Weighing Machines, A. W. Hosking, Manchester.
17242 Making Paper Boxes, H. J. Allison, London. (J. R. Stout, United States.)—[Complete Specification.]
17265 Barrels, J. Y. Johnson, Middlesex. (H. Reed and C. M. Lea, United States.)—[Complete Specification.]
17268 Driving Belts, J. Caillet, London.—[Complete Specification.]
17270 Steel, M. Graff, London.—[Complete Specification.]

November 28th.

17281 Multiple-cylinder Engines, H. J. H. King, Gloucestershire.
17293 Steam Trap, J. Gullery, Belfast.
17296 Adjustable Spanner, E. Barnes and J. B. Bromley, Birmingham.
17299 Steam Engines, A. Morton, Glasgow.—[Complete Specification.]
17317 Briquette Machines, F. H. G. H. Stockfleth, Middlesex.
17329 Cutting Tubes, A. Kellar and A. J. Marquand, Middlesex.
17334 Wrenches, W. D. Bohm, London.
17335 Furnace Shells or Flues, W. Phillips, London.
17342 Rotary Engines, J. A. Radiquet, London.
17343 Motors, W. Schmidt, Berlin.

November 29th.

17352 Paper-folding Machines, L. Munro, Dingwall.
17354 Furnaces, J. Allan and E. S. Dixon, South Shields
17360 Forming Cogs of Wheels, W. Ashton, Manchester.
17362 Heat Regulator, C. W. Summerskill, Warwickshire.
17368 Silicon-bronze, T. Parker and A. E. Robinson, Manchester.
17373 Smelting, R. Middleton, Leeds.
17375 Matallic Boxes, S. Timings, Birmingham.
17382 Planing and Boring Machines, J. Crow, Glasgow.
17383 Toughening Metals, R. B. Hansell, Sheffield.
17395 Lubricating Apparatus, J. Durie, Glasgow.
17397 Screw Nuts, J. Hampton and S. Partridge, Middlesex.
17407 Steam Generators, R. Tobin, London.
17409 Metal Bolts and Nuts, J. G. Crampton, Westminster.
17412 Steam Boilers, H. H. Lake, London.
17421 Motive Power, A. A. F. Davis and H. Haward, London.—[Complete Specification.]
17423 Governor, T. G. Stevens, Kent.
17424 Feed-water Mechanism, J. Murrie, Glasgow.

November 30th.

17437 Axles, A. T. Allen and J. C. Bayley, Sheffield.
17445 Combined Nut and Spring, W. T. Fitzgerald, Bristol.
17449 Locomotive Engines, J. Blake, Manchester.
17450 Recovery of Zinc, C. A. Burghardt, Manchester.
17451 Ventilators, St. J. V. Day, Glasgow. (P. S. Swan, India.)
17455 Water Apparatus, J. Winterflood, London.—[Complete Specification.]
17464 Brake and Apparatus, J. H. Shorrock, London.
17469 Automatic Filter, F. M. Dixon, South Hampstead.
17471 Roller Mills, G. C. Dymond, Liverpool. (J. A. McAnulty, United States.)
17480 Mechanism, J. A. F. Aspinall, London.

December 1st.

17503 Polishing Machinery, J. Cadbury, Birmingham.
17505 Tuyere Coils, T. G. Barlow-Massicks, Middlesbrough.
17512 Steering Gear, A. Fisher, jun., and R. Richardson, Glasgow.
17517 Gas Apparatus, F. J. Jones, Leek.
17518 Stone-breaking Machines, S. Mason, Leicester.
17521 Crucibles, E. J. T. Digby, London.
17538 Gas-holder Construction, F. Weck, Birmingham.
17542 Cutting Tubes, A. Kellar, London.
17557 Marine Boiler, G. Kingdon, London.
17562 Gas Apparatus, De W. Stearns, London.—[Complete Specification.]

December 3rd.

17573 Mechanical Stoker, J. Proctor, Manchester.
17578 Taps, Cocks, or Valves, S. A. De Normanville, Liverpool.
17585 Brake System, A. C. T. Bautian, London.—[Complete Specification.]
17597 Lifts and Hoists, H. C. Walker and R. Carey, London.
17611 Elevators, V. Petherick, London.—[Complete Specification.]
17617 Forced Draught, A. McInnes, Glasgow.—[Complete Specification.]
17625 Friction Brake, T. G. Stevens, London.
17626 Pulverising Apparatus, E. Burton, London.
17631 Nitro-glycerine, H. R. Von Dahmen, London.

December 4th.

17638 Manufacture of Iron, G. G. Mullins, London.—[Complete Specification.]
17643 Steam Pipes, T. Winter, Halifax.
17647 Water Gauges, R. Brown, Newcastle-on-Tyne
17657 Oil Cans, J. Kaye, Leeds.
17658 Metallic Tubes, F. D. Everitt, Middlesex.
17661 Combustion of Smoke, G. E. Davis, Manchester.
17683 Nut Locks, J. D. Cleek, London.—[Complete Specification.]
17684 Engine-speed Counter, A. King, London.
17696 Water Motors, H. A. Strong, London.
17698 Metallic Rod Packing, T. Falk, London.—[Complete Specification.]
17704 Boilers, C. S. Smith and G. H. Davis, London.

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Wanted, Second-hand Root's BLOWER, capable of melting two to three tons of iron per hour.—Particulars and price to SHORE, Engineer, Hanley.

Wanted, Overhead Traveller, to lift ten tons; 30ft. span (about), worked from below.—Apply, giving price and particulars, to GIMSON AND Co., Engine Works, Leicester.

Wanted, Good Second-hand WIRE ROPES, 1¼in. to 2½in. circumference; also Hand DRILLING MACHINE and FLY PUNCH. Address, H., *Practical Engineer* Office, Manchester.

Wanted, a Second-hand STEAM HOIST or COAL ELEVATOR for pit bank.—Full particulars to A.B.C., *Practical Engineer* Office, 6, Victoria Station Approach, Manchester.

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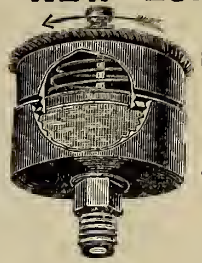

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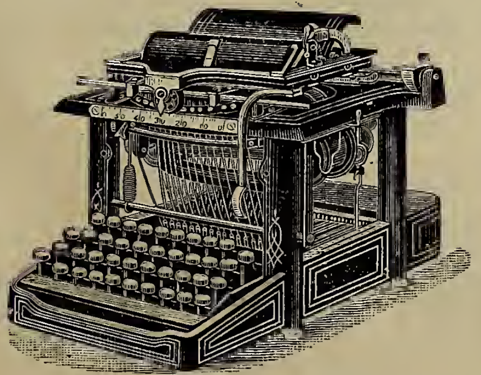

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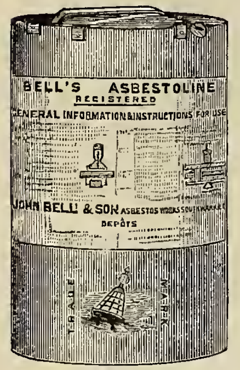
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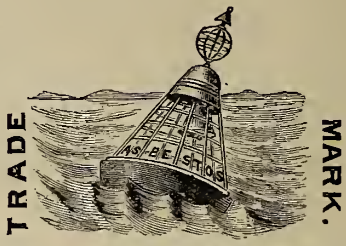

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The Laboratory, 11, Billiter Square, E.C., London, 3rd May, 1888.

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(Signed) OTTO HEHNER, Public Analyst.

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Numerous complaints having been made to us by Subscribers of the difficulty they experience in obtaining copies of *The Practical Engineer* in certain districts, we have to state that the Journal can be obtained by any Newsagent through the ordinary trade channels, and no difficulty should therefore exist in obtaining copies *by order* of any Newsagent.

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EDITORIAL NOTICES.

All communications for the Editor of this Journal should be addressed to 6, Victoria Station Approach, Manchester.

Communications intended for insertion in the current week's issue should reach us not later than Tuesday Evening.

We cannot undertake to return rejected manuscripts or drawings unless accompanied by a stamped and directed envelope.

Contributors are requested to write on one side only of the paper. Sketches should be sent on separate sheets.

TO ADVERTISERS.

Advertisements intended for insertion in the current issue should reach our Manchester Office on Wednesday Morning *at the latest.*

THE
PRACTICAL ENGINEER.

DECEMBER 21ST, 1888.

THE BOILER EXPLOSIONS ACT.

On another page will be found the sixth annual report, which has just been issued, upon the working of the Boiler Explosions Act, 1882, by Mr. Thomas Gray, the Assistant Secretary to the Marine Department of the Board of Trade.

From this report it appears that during the twelve months ending June 30th, 1888, inquiries were held with regard to 61 "boiler explosions" which occurred within the meaning of the Act. The term "boiler explosion," however, as understood by the Act, is exceedingly elastic, and, as we have frequently pointed out in reviewing the reports of Preliminary Inquiries, embraces a number of cases of failure which can hardly by any stretch of imagination be characterised as boiler explosions according to the general acceptation of that term.

The trivial character of the bulk of the inquiries referred to is well illustrated when the figures given in the report are analysed. The 61 cases referred to resulted, according to the report, in a total loss of 31 lives, but it would appear that more than one half of this total loss arose from two explosions—one which occurred on the steamship Elbe, from the bursting of a copper steam pipe, on the 19th of Sep., 1887, resulting in 10 persons being killed; while the second, which occurred from the bursting of a Rastrick boiler at an ironworks at Brockmoor, in Staffordshire, on Oct. 11th, 1887, caused the loss of 7 lives. If these two explosions be subtracted from the total return, we have the loss of 14 lives as a measure of the fatality of 59 explosions, which gives rather more than four explosions for each person killed.

While disclaiming any intention of regarding loss of life, from whatever cause, with levity, we must say that it is difficult to repress a feeling of contempt for the efforts which are periodically made by officious wirepullers and pseudo philanthropists to magnify such trivial casualties as these into disasters of the first magnitude, and to persuade an unsuspecting public that the question of boiler explosions and boiler inspection is one of pressing national importance calling for interference.

Our criticisms are not aimed so much at the statistics furnished in the Board of Trade report as at the unfair use which is made of them. We are quite aware that the department is bound by the clauses of the Act to issue a report of every preliminary inquiry that is held, however trivial or trumpery the casualty itself may be; while further, that every such casualty, whether it consists merely in the blowing out of a fusible plug, the fracture of a water-gauge fitting, or a mere crack through which it would be almost impossible to slip a sixpence, is an explosion according to the Act; but although such casualties may bear such an interpretation in the eye of the law, they certainly do not when looked at from a common-sense point of view, and we are led to make these remarks in order to prevent the public being misled by designing persons, who seek to throw dust in their eyes with regard to these facts whenever the question of boiler explosions comes to the front.

If we take the whole of the six years during which the Boiler Explosions Act has been in operation, we find that 284 cases have been inquired into, involving a loss of 180 lives, being an average of 30 per annum. Although loss of life, from whatever cause, is never very pleasant to contemplate, yet the amount in question sinks into complete insignificance when compared with that arising from other industrial occupations. For every person killed by a boiler explosion there will probably be a score killed in London by street accidents alone; while the deaths that annually occur from accidents in mines and on railways will amount to more than those arising from boiler explosions, at the present rate, during the next fifty years.

The increase of the death rate by one per thousand in a small town of 30,000 inhabitants would result in as great a loss of life as that arising from all the so-called boiler explosions throughout the United Kingdom, a little fact we would commend to the attention of those philanthropists anxious for an outlet for their surplus energies. If our philanthropic friends are as sincerely anxious to relieve human suffering and save life as they profess to be, we would advise them to devote their attention to sanitary subjects. We can assure them there is adequate scope for their energies in this direction, and although notoriety might not be so cheaply obtained, yet the expenditure of an equal amount of effort to that devoted to the promotion of boiler legislation would be productive of infinitely greater benefit to mankind.

The number of boilers in the United Kingdom is variously estimated at 120,000 to 150,000. Taking the lower number for the sake of illustration, and dividing by 30, we have one life lost per annum for each 4,000 boilers, with all their steampipes and connections. When we come to compare this toll with that exacted in the occupation, say, of a miner, we realise how small is the price which civilisation pays in this country for the advantages attendant upon the use of steam. From the official returns of mining accidents for 1887 it appears that during that year one life was lost for every 529 miners engaged; or, in other words, the risk in connection with a miner's occupation was about eight times as great as that attending the working of a steam boiler. We very much question whether any serious reduction in the number of casualties attending the use of steam would be produced by any amount of legislation, for it must not be forgotten that the annual loss of 30 lives referred to includes many cases of gross recklessness on the part of attendants, and many others in which the effects could not have been discovered by the most painstaking inspection. If the loss of life from these causes be subtracted, the remainder would be very small indeed. A certain amount of risk is entailed in riding in a cab or on the railway, but no member of the community hesitates to run this risk for the sake of the advantages gained, and in a similar way society is prepared to pay a certain price for the advantages attendant upon the use of steam. How small is the tribute already levied will be apparent from the figures quoted and the comparisons we have instituted.

In estimating the need, therefore, for any legislative interference, it is well to bear these facts in mind should the question ever again be brought prominently forward. All reference to the subject of legislation, we may remark, has been carefully avoided in the present report, although the question occupied a position of considerable importance in previous ones. Possibly the absence of any reference to the subject of legislation may be one result of the recent translation of Lord Stanley, the late President of the Board of Trade, to the Governor-Generalship of Canada, and his replacement by Sir Michael Hicks-Beach. We hope the present holder of the office will continue to exercise the caution already displayed, and can assure him that the agitators who periodically seek to invoke Government interference with regard to boiler inspection have little claim to represent the views either of steam users or the public.

There can be no doubt that the Boiler Explosions Act has been very beneficial in reducing the death rate from boiler explosions during the six years it has been in operation, by acting as a salutary check both upon boiler owners and boiler inspectors. We cannot but think, however, that its benefits would have been more manifest if the whole of its clauses had been more frequently put into operation. In only one instance, so far, has the Board of Trade availed itself of the power under the Act to appoint a "Formal Inquiry" with regard to an explosion, and this was in the case of the explosion of the Rastrick boiler at Brockmoor, on October 11th, 1887, to which reference was made in the early part of this article. This inquiry, according to the annual report, was held "because the loss of life was serious, while the boiler which exploded was under the inspection of a boiler insurance company." We trust, however, that the appointment of a formal inquiry is not always determined by reference to these conditions alone. Several instances have occurred, from time to time, since the Act was passed in which the explosion has been the result of gross, not to say criminal, recklessness on the part of the owner; and we cannot but think that the appointment of a formal inquiry, with the infliction of its costs as a punishment upon the defaulting owner in cases calling for interference, would have tended very much to enhance the usefulness of the Act, by strengthening the hands of boiler inspection and insurance companies in dealing with parsimonious boiler owners, and by instilling in the minds of the latter a more just sense of their responsibilities.

THE IRISH EXHIBITION AT THE OLYMPIA.

STARTED with good intentions, and under good patronage, it would appear that intentions and influence combined were powerless to secure financial success, for the company which was responsible for the Irish Industrial Exhibition, and which was wound up on Saturday, the 15th inst., has to announce a deficit in its balance sheet of £15,000 to £20,000. This loss apparently will not, as in the case of the Liverpool Exhibition, fall exclusively upon its guarantors. The gentlemen who undertook to fill this onerous position for the "Olympia" were only seven in number, and appear to have taken care to protect themselves against any individual responsibility exceeding the modest sum of £10. The creditors apparently do not seem to have been aware of this cautious and shrewd arrangement, so that they will be the main sufferers from the failure of the undertaking. The promoters, it appears, were permitted by the Board of Trade to dispense with the use of the word "limited" after the title of the company, a concession usually reserved for associations formed for the purpose of promoting commerce, art, science, &c. It is suggested that, in order to avoid misapprehensions arising in the minds of creditors in the future, it would be well if the Board of Trade published a list of all the companies to whom the dispensation, with regard to the title of "limited," has been granted, in order that creditors may have a better opportunity of preventing their just claims being unduly prejudiced.

COLLAPSE OF THE PANAMA CANAL COMPANY.

THE long impending collapse of this undertaking has at length occurred, and the desperate efforts which have been made by the directors for some time to postpone the catastrophe have but rendered the final crash all the greater. It would be difficult indeed to conceive a more ruinous financial collapse in connection with any commercial undertaking than that which has befallen the Panama Ship Canal Company, nor one which offers fainter possibilities of recovery to the shareholders who were unfortunate enough to back up M. de Lesseps' project with their pockets in the first instance, nor is it possible to see how that veteran canal maker can escape from the disaster which has befallen him. It is almost impossible to realise the widespread ruin which the failure of this enterprise will entail upon the thrifty and provident class in France, where by far the greater part of the gigantic sums that have been swallowed up has been subscribed. The original estimate for the cost of the undertaking was put down at 1,200,000,000 francs, the intention being to cut a tidal canal from the Atlantic to the Pacific. Before this sum was spent, however, it was seen that the estimate was utterly inadequate to accomplish the undertaking as it was first designed, and the original plan was modified for a cheaper method of construction, involving the use of locks. But although further sums were subscribed on the understanding they would permit of the completion of the undertaking, the company has been compelled, after the expenditure of 1,400,000,000 francs, to admit that the scheme is still incomplete, and that upwards of 350,000,000 francs would still be required before a vessel could pass from ocean to ocean. It is the failure of M. de Lesseps' efforts to raise this further sum that has brought about the final crash. Up to a few days ago it was thought that, as the bulk of the capital was subscribed by Frenchmen, the Government would be morally compelled to come to the assistance of the undertaking, and, like drowning men grasping at the proverbial straw, the shareholders buoyed themselves up with hopes of aid in the shape of special governmental relief. From the action of the French Parliamentary Committee, however, confirmed as it has been by the Chamber, it would appear that no assistance is to be looked for in that quarter, and indeed we do not see what can possibly intervene to save the bulk of the 870,000 shareholders from absolute financial ruin.

IMPROVEMENTS IN MINING.

At the inaugural meeting of the session of the North of England Institute of Mining and Mechanical Engineers, held at Newcastle on Saturday, the 8th inst., Mr. J. Marley, the president, in the course of his address, quoted some interesting figures from the Government mining and mineral statistics for 1887, to illustrate the improvement that had been effected within the last quarter of a century with regard to the safety of human life in mining operations. From the official return for 1887, it appears that the death-rate from accidents in mines for each 1,000 persons employed was 1·89, or 1 to every 529 persons employed, whereas 30 years ago the death-rate was 1 in 245; so that the risk of the coalminer's occupation had been reduced during that period to less than one-half. Alluding to the warnings issued by the meteorological office, Mr. Marley said that, whilst personally disinclined to say anything which might even appear to discourage endeavours to avoid accidents, he felt bound to say he entertained great doubt as to the value of these warnings, and certainly thought too much reliance should not be placed upon them. He was afraid that if mine managers made their action dependent entirely upon the warnings, they would frequently find themselves a day too late. Referring to the substitution of machine for hand labour, he thought there was still a great deal to be done in this direction, and that the tendency of the adoption of underground machinery would be to largely reduce the number of accidents. Regarding economy in production and consumption of coal, he thought there was still great room for reform, and that inventors should devote their energies towards securing the utilisation of the coal which was mined, rather than to the search for substitutes for coal. As illustrating the improvements that had been effected in boring and drilling appliances, he referred to the boring of the salt wells in South Durham, where the American boring engine had proved a very formidable competitor, having bored a hole at the rate of 5ft. per hour, with an average of 63ft. per diem. Touching the question of safety lamps, he said that although electric light had recently made rapid progress, yet much remained to be done before a miners' lamp was produced which could be said to be really perfect under all conditions.

MATERIALS OF ENGINEERING.—IX.

Steel. (*concluded*).

The remarks made in reference to the modes of testing employed for wrought iron will also hold good in regard to the mild steels. The forms of test pieces, the bending tests, as well as the injurious effects of punching, shearing, hammering, and flanging, are pretty much the same for both materials.

The Admiralty specify that the mild steel such as is used by the Government for shipbuilding shall have a tensile strength of not less than 26 tons nor more than 30 tons to the square inch, and that a specimen piece 8in. long shall stretch 20 per cent of its length before fracture, the test pieces to be cut both ways of the plate. Lloyd's require a tensile strength of from 27 to 31 tons, with 16 per cent of elongation in an 8in. test piece. The Liverpool Underwriters demand 28 to 32 tons per square inch, with an elongation of 20 per cent in an 8in. test piece. For bending test the Admiralty require that strips 1½in. in width, cut either lengthways or crossways from their plates, shall bend cold to a curve whose radius is equal to that of the thickness of the plate, and that a similar strip after being heated uniformly to a low cherry red, and quenched in water at a temperature of 32 deg. F., shall bend to a curve whose radius is one and a half times the thickness of the plate.

The experiments of the Board of Trade, whose report was issued in 1881, gave for mild steel plates of various thicknesses a mean of about 29 tons tensile strength, with a percentage contraction area ranging from about 38 to 53 per cent, and an elongation of from about 21 to 30 per cent.

In Glasgow Exhibition, at David Colville's stand, was shown a boiler shell plate measuring 30ft. by 7ft. 3in. by 1in., which had a tensile strength of 30·5 tons, and an elongation of 26 per cent in an 8in. test piece, and this is a fair sample of strength and elongation. Abundant examples occurred of the ductility of mild steel in bars bent and twisted cold like the best wrought iron without fracture.

The large size to which homogeneous steel plates can now be rolled is remarkable. The Steel Company of Scotland had a plate in the exhibition measuring 130ft. by 18in. by ⅝in., rolled into a coil, whose inner diameter was 20in. David Colville had an end shell plate, 10ft. diameter by ¾in. thick. John Brown showed a steel pan, 9ft. 3½in. diameter, 2ft. 2in. deep, with an average thickness of ¾in., made out of a flat plate, 10ft. 8in. diameter, without weld, and dished in a hydraulic forging press. A large Siemens steel plate, for the Fairfield Shipbuilding Company, measured 28ft. by 9ft. by 1⅛in.

There are two noteworthy points about the testing of mild steel, one being the limitation of the tensile strength to 30 or 32 tons; the other the operation of heating and quenching in water. Steel plates were long held in disrepute because of their liability to crack. This was due to their excessive hardness, ductility being sacrificed to high tensile strength. We now know that the two qualities cannot exist in perfection in the same material, and that to obtain reliable plates a compromise must be effected between the two; and by hardening we impose a very severe test on steel. The effect of hardening by quenching in water is to increase the tensile strength, and diminish the percentage elongation. Thus a specimen of mild steel, whose tenacity was 29 tons, was treated and quenched in water at 80 deg., by which operation its tenacity was increased to 43 tons; but then its percentage elongation was diminished in 10in. from 23 to 5. The effect of hardening on the composition of the steel is probably akin to that of the chilling of cast iron—the separation of the carbon being prevented. Further, the higher the percentage of carbon, the more pronounced is the effect of quenching, the tensile strength increasing rapidly in proportion, and the percentage elongation diminishing. Manganese and phosphorus also affect the steel in much the same way as carbon in this respect.

Bauschinger experimented carefully on the influence which carbon has upon the strength and ductility of Ternitz steel. With a percentage of ·14 of carbon the ultimate tensile strength was only 28·1 tons, but the percentage elongation in a length of 16in. was 21·8, and contraction of area 49·2 per cent. At the opposite extreme, with a percentage of ·96 of carbon, the tensile strength was 52·7 tons, and the percentage elongation only 6·6, and contraction of area 10. The test pieces had a cross section of 2·8in. by 0·48in.

The strength and ductility of steel castings depend on small differences in chemical composition. They will have a tenacity of from 20 tons to 40 tons, but increase in carbon and silicon much diminishes their ductility. Thus Mr. Foster cites, amongst other samples, a casting having ·30 of carbon, ·22 of silicon, ·63 of manganese, whose percentage contraction of area was 43·8, and another having ·96 carbon, ·62 of silicon, and ·64 of manganese, whose percentage contraction of area was only 1·8.

TRIPLE-EXPANSION ENGINES IN 1886-7.

As a study of the alterations effected by marine engineers to the machinery of old vessels during 1886 and 1887 will doubtless prove interesting to those of our readers connected with the mercantile marine, we have prepared a list of those engines which were tripled or quadrupled during these two years, and the table on page 628 gives the details of the old and new machinery in the case of those vessels which were altered during 1886, with the dimensions of the vessels, and the names of the engineers by whom the alterations were carried out.

That there is a large scope for manufacturers in this direction is very evident from the great number of vessels afloat, whose machinery and boilers, especially the latter, have run their course of years, and are now feeling the strain, if not of old age, at least of continuous work, with its resultant infirmities. That shipowners are ready to embrace the opportunities afforded them for employing the skill of the engineer in turning out economical working engines is also evident from the manner in which they have appreciated the advantages of the triple and quadruple expansion engines.

LIST OF VESSELS WHOSE ENGINES WERE TRIPLED OR WHICH HAD NEW ENGINES AND BOILERS FITTED IN 1886.

Name of Ship.	Date.	Length.	Breadth.	Depth.	Old Engines. Cylinders.		Old Engines. Stroke.	Old Engines. Pressure.	New Engines or Alteration. Cylinders.			New Engines or Alteration. Stroke.	New Engines or Alteration. Pressure.	Owners.	Engineers.	Remarks.	
Athenian	1881	365	45	29	50	94	54	90	36	58	94	54	160	Union Steamship Co. ..	T. Richardson & Sons.	Engines Tripled.	New Boilers.
Bentick	1873	232	29	16	23	46	24	60	15	20	46	24	160	C. Jones, Esq.	J. Jones & Sons......	Ditto	ditto
Birkhall	1878	250	32	17	31	57	36	70	17	31	57	36	160	Grampian Steamship Co	Hall, Russell & Co. ..	Ditto	ditto
City of Edinburgh ..	1876	381	38	29	52	89	48	70	30	44	73	48	150	G. Smith & Sons	J. & J. Thomson	Ditto	ditto
City of Lincoln	1866	335	42	27	$\frac{2}{35}$	$\frac{2}{60}$	42	—	26	42	68	42	160	W. H. Ross & Co........	W. Doxford & Sons ..	New Engines	ditto
Congella	1881	255	34	23	33	62	42	80	21	34	56	42	150	Bullard, King & Co.....	G. Clark, Esq.	Ditto	ditto
Constantin	1870	194	23	14	22	36	36	70	12½	20½	34	—	150	(Foreign owned)	Ditto	Ditto	ditto
De Ruter	1873	316	35	27	38	66	42	—	21	33	66	42	160	T. C. Engels & Co.	Wallsend Shipway Co.	Engines Tripled	ditto
Ehrenfels	1882	303	36	26	38	72	48	80	25	38	72	48	150	(Foreign owned)	Wigham, Richardson & Co.	Ditto	ditto
Etna	1874	235	31	17	28	53½	33	70	17	28	46	33	160	Herskind and Woods ..	Blair & Co., Limited.	Ditto	ditto
Florence Richards ..	1873	221	30	16	27	51	33	65	18½	27	48	30	150	R. Nicholson & Sons ..	J. Jack & Co.	Ditto	ditto
Minerva	1867	207	27	16	24	44	28	70	14	24	44	28	135	J. & P. Hutchison	Hutson & Corbett....	Ditto	ditto
Spartan	1881	363	48	29	51	88	60	75	34	51	89	60	160	Union Steamship Co. ..	T. Richardson & Sons	Ditto	ditto
State of Nevada	1874	332	36	28	46	82	46	70	21, 21	46½	73	46	150	The State Steamship Co.	D. & W. Henderson & Co.	Engines Quadrupled	ditto
Thames	1871	282	34	24	34	60	36	60	21½	33	54	36	150	W. Ross & Co.	D. Rollo & Sons	New Engines	ditto
Vespasian	1872	269	30	20	30	57	30	—	17	29	46	30	160	W. H. Dixon, Esq.	Ditto	Ditto	ditto
Vlissingen	1872	147	21	8	—	—	—	—	10	16	26	18	150	G. W. & W. H. Tyser ..	——	Ditto	ditto
Windsor	1866	210	28	13	30	56	30	60	18	30	56	30	140	G. Gibson & Co.	Hawthorns & Co.....	Engines Tripled	ditto

Since the days of compounding the condensing engines, very little alteration to the machinery of old vessels has taken place, but under the new aspect, with high pressures and correspondingly small coal bills, it would appear that there is likely to be plenty of work in the immediate future.

Some of the old vessels in our list have undergone alterations to the engines for the second time; that is, they were originally constructed on the simple condensing principle, and then were compounded, and have now been "tripled" or "quadrupled," or the old one taken out and new ones filled in, as the case may be. On the other hand, a few of the vessels are quite modern, and the compound machinery has seen only a few years, a long way under the average life, and the alteration effected may be said to be from an economical point of view, which is about the best point from which successful engineering can be inspected.

(*To be continued.*)

A NEW MINERS' SAFETY LAMP.

At the last monthly meeting of the Manchester Geological Society, held on the 11th inst., a paper was read by Mr. John Higson, F.G.S., on a new portable electric lamp for mining purposes, manufactured by the Mining and Electric Lamp Co., Limited, London. The principal feature claimed for the new lamp was the lithanode secondary battery, introduced by Mr. Fitzgerald in 1885, the negative element of which consisted of a dense, hard, and highly conductive plate of solid per-oxide of lead, and which, it was stated, no other substance yet known could compete with. A two-cell miners' lamp of one candle power, constructed with this material, only weighed from 4lb. to 5lb. The electric motive force of the battery was four volts, and the lamp would burn twelve hours with one charge from a dynamo machine of five hours. The lamp could be placed wherever it was best suited to meet the requirements, and might be detached altogether from the battery as in the case of a small railway reading lamp, ready to be affixed to the coat or cap. Another advantage, in addition to the portability of the lamp, was that no renewal of elements was required, nor of the electrolyte (which was dilute sulphuric acid), while no gases were evolved on discharging the current through the lamp, and therefore there was no necessity for valves or other complicated arrangements to emit gas without the liquid. The following particulars were given with regard to the cost and maintenance of an installation of 1,000 lamps: 1,000 lamps, at 20s., £1,000; 1 5in. dynamo machine, £75; instruments, wires, &c., £15; total, £1,090. Maintenance per annum: Interest on £1,090 at 5 per cent, £54 10s.; depreciation on £1,090 at 10 per cent, £109; current, 7,800 units at 7d., £227 10s.; wages, two men at £52, and three boys at £19 10s., £162 10s.; incidental expenses, £10 10s.; total, £564, which is equal to 2½d. per lamp per week, burning twelve hours per day, six days per week. The lamp, it was stated, had been tested for a period extending over nine months at several of the largest collieries throughout the North of England, and in all cases had, it is said, met with a flattering reception.

REPORT UPON THE WORKING OF THE BOILER EXPLOSIONS ACT.

The following is a copy of the sixth annual report upon the working of the Boiler Explosions Act, 1882, dealing with the twelve months ending June 30th, 1888. The report, which is addressed to the Secretary of the Board of Trade by Mr. Thomas Gray, Assistant Secretary to the Marine Department, is as follows:—

During the twelve months ended 30th June, 1888, inquiries were held in 61 cases of boiler explosions. This is the largest number of cases dealt with in any year since the Act came into force, although the loss of life from explosions during the twelve months referred to was about the average for the six years 1882-8, the numbers for the whole of this period being:—

Year.	Cases.	Lives lost.
1882-3	45	35
1883-4	41	18
1884-5	43	40
1885-6	57	33
1886-7	37	24
1887-8	61	31
Total for 6 years......	284	180

With regard to the loss of life, it may be remarked that in two cases last year the explosions were followed by unusually disastrous results. By the explosion of a copper steam pipe on board the steamship Elbe, during a trial of the vessel's machinery, all the persons in the stokehole, ten in number, were killed; and by the giving way of the shell of a Rastrick boiler, at the Leys' Ironworks, Brockmoor, Staffordshire, seven persons were killed. In the latter case a formal investigation before two commissioners was ordered. This is the first instance in which such an inquiry has been held, but as the loss of life was serious, while the boiler which exploded was under the inspection of a boiler insurance company, it was deemed advisable to investigate the matter before a formally constituted court.

In fourteen of the cases dealt with during the year the boilers were inspected on behalf of insurance companies, but in three of these the explosions were caused by the neglect of the boiler attendant; while in three others the companies had called attention to defects before the explosions occurred.

In eighteen cases the boilers were in use on board vessels, and in three of these they were used for hoisting trawls. There is reason to believe that many of the boilers used for this purpose are in a seriously defective condition, the men placed in charge of them being frequently altogether unskilled in their management, and the system of inspection very inefficient.

As in former years, the practice of using boilers which are either worn out or seriously defective has again been the chief cause of explosions, thirty-one of the sixty-one cases dealt with being due to causes of this kind. Of the remaining cases, seventeen were due to defective designs and fittings or undue working pressure, seven to neglect or ignorance of the attendants, and six to miscellaneous causes.

Legal proceedings have been instituted under the Boiler Explosions Act in only one case during the year, the owner of the boiler referred to under Report No. 268 having been prosecuted for omitting to report the explosion which had occurred. A conviction was obtained, and a mitigated penalty of 20s. and costs inflicted.

In the case referred to under Report No. 243, a criminal prosecution was instituted by the county authorities against the attendant of the boiler. A committal for trial on a charge of manslaughter resulted from the preliminary proceedings; but when the case was heard at the assizes a verdict of "Not guilty" was returned.

THOMAS GRAY,
Assistant Secretary, Marine Department.
To the Secretary of the Board of Trade.

NEW CRUISER FOR THE RUSSIAN NAVY.

THE new armoured cruiser, the Imperator Nicholas, which has recently been launched on the Neva, will constitute a very powerful addition to the Russian navy. She is a sister ship to the Imperator Alexander II., which was launched at Cronstadt last year, and may be described as a twin-screw composite brig-rigged armoured barbette cruiser, of much the same general character as our own Warspite and Impérieuse, but larger, and considerably heavier armed and armoured than those vessels.

The value of this class of cruiser was amply proved last year, when, during the summer manœuvres, the Impérieuse rendered most valuable assistance to Admiral Freemantle in the Channel; and again this year, when the Warspite led the Iris and Severn out of Bantry Bay, and subsequently distinguished herself as the most useful member of Admiral Fitzroy's squadron of depredation. It is well known, however, that the Warspite and Impérieuse have grave defects, but the Russian vessels will, it is expected, be free from most, if not all, of these. In one particular only are they even nominally inferior to the British cruisers. They are not intended to steam quite so fast on their trials.

The Imperator Nicholas is of 8,440 tons displacement, and the indicated horse power of her engines is 8,500. The present displacement of the Warspite greatly exceeds that which she was originally designed to possess, and may be set down at 8,400 tons, but her most favourable fighting displacement would probably be about 7,500 tons; whereas the Imperator Nicholas, with the proper proportion of her belt submerged, will displace nearly 1,000 tons more. The difference expresses pretty accurately the real difference in size between the two ships.

The Russian cruiser is 326ft. long and 67ft. in breadth, and will have a mean draught of 23ft. She is armoured along the whole length of her water-line with a belt of compound armour, having a maximum thickness of 14in. She is, in addition, protected by a horizontal steel deck 3in. thick, placed immediately above the belt; and her two barbettes will carry 12in. compound armour. Finally, her stability, even if she should be pierced in several places at the water-line, will be insured by the great number of water-tight compartments into which the ship's hull is divided.

The vessel's armament will be exceedingly powerful. Each of the barbettes will carry a single 12in. 52-ton breechloader, throwing a projectile weighing 730lb., with a charge of 255lb. of powder. The perforation of this weapon at its muzzle is 24in. of wrought iron, and no heavier gun is mounted on any Rusian warship. The secondary battery consists of four 9in. 15·7-ton breechloaders, mounted behind protective shields. Each of these guns throws a 278lb. projectile, with a charge of 64lb. of powder, and can perforate 13in. of iron. The tertiary battery is composed of eight 6in. 4·12-ton breechloaders, the projectile of each weighing 82lb. and the charge 34lb. The perforation at the muzzle is 7in.

In addition, the ship is to be provided with four quick-firing and six machine guns, and with four torpedo launching tubes; and it is proposed, though not decided, to give her as well four 3½in. breechloaders. These may, however, be left out of the calculation, if it be desired to compare the Imperator Nicholas and her sister ship, the Alexander II., with our own Impérieuse and Warspite, the only vessels of anything like similar class which we possess.

As our Impérieuse has been sent to the Pacific, and the Russian cruisers are destined for the same station, it is convenient to institute a comparison between vessels which would, in the event of the outbreak of hostilities, most probably be opponents. This may be done as follows :—

	British.	Russian.
	Impérieuse or Warspite.	Alexander II. or Nicholas.
Displacement in tons	8,400	8,440
Indicated horse power	10,000	8,500
Estimated sea speed	15·7	15·6
Maximum thickness of armour	12in.	14in.
Number of heavy guns	10	14
Weight of heavy guns	126 tons	199·76 tons.
Weight of broadside	1,060lb.	1,614lb.
Perforation of heaviest gun	19in.	24in.
Complement	514	570

Nor is this all. The Russian ships, as has already been noted, have complete belts at the water-line. The British ships have not; and, in a moderate sea-way, the partial belts which they do possess would, at the present displacement of the vessels, be at times wholly under water. It should be borne in mind, moreover, that whereas each Russian ship carries six guns which can at close quarters pierce the thickest armour of the British cruisers, each British ship carries only four guns which can, in similar circumstances, pierce the thickest armour of the Russian vessels. The Impérieuse and Warspite are undoubtedly good ships of their class; but they are far from being the most modern types of that class, and it is plain that the launch of the Imperator Nicholas and the approaching completion for sea of the Imperator Alexander II. are events which should cause us to seriously consider our position in the matter of armoured cruisers.

SOME TYPES OF THE MODERN LOCOMOTIVE.—II.

(Continued from page 621.)

FIG. 2 is a sectional elevation and half plan of the Caledonian express engine designed by Mr. Drummond, and is a fine example of the single driving wheel engine.* Contrary to the usual practice when large single drivers are employed, the cylinders are between the frames, and are 18in. diam. and 26in. stroke. The driving wheels are 7ft. diam.; bogie wheels 3ft. 6in. diam.; and trailing wheels 4ft. 6in. diam.

The working pressure is 150lb. per square inch; the boiler having a total heating surface of 1,085 square feet, 973ft. being in the tubes, and 112ft. in the box, with a grate area of 17·4 square feet.

The weights on the rails when the engine is in full working order are :—

On the bogie	13·5 tons.
" drivers	17·0 "
" trailers	11·4 "
Total	41·9 tons.

It has a six-wheeled tender, with wheels 4ft. diam. and 13ft. wheel base, which carries 2,850 gallons of water, and weighs when loaded 33½ tons.

The slide valves of this engine are divided; one-half of the exhaust steam passes round the cylinder barrel, joining the rest above, and thus forming a partial steam jacket. It will be seen that although the frames have been cut away at the sides to allow the cylinders to be got between, the exhaust cavity in the slide valve is much contracted ; and although special provision has been made for getting the exhaust steam away in the manner before described, without a sufficient area through the valve itself the exhaust must be throttled, and the result will be increased back pressure in the cylinder.

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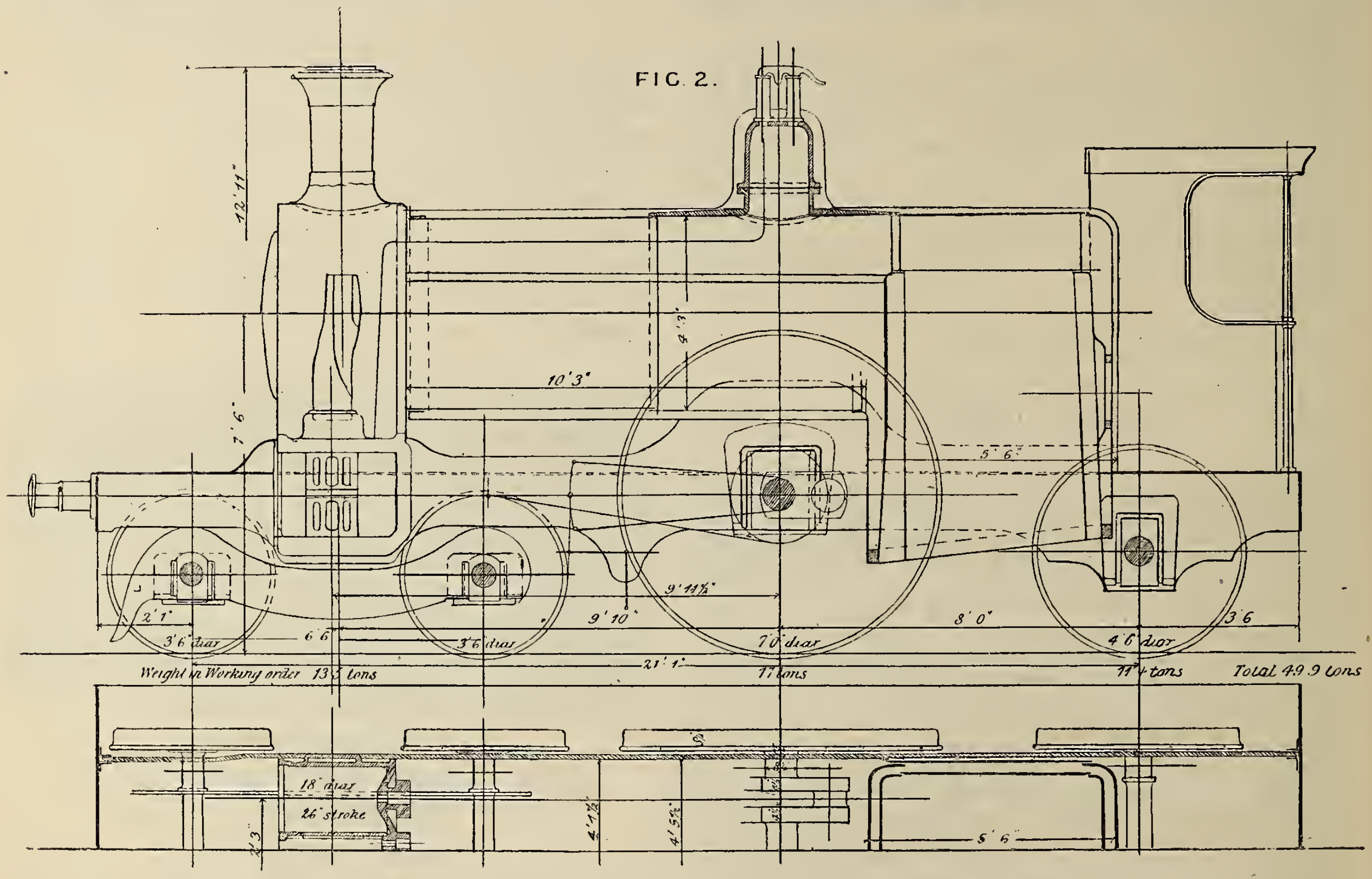
* We gave an illustration of this engine in our last week's issue, but have repeated it in order to make the text more intelligible.

A special feature is the use of Mr. Adams' vortex exhaust pipe, in which the exhaust steam escapes through an annular space, the centre of the pipe being expanded below to a wide opening which faces the lower tubes. The object is to increase the draught through the bottom rows of tubes, which, as the gases in the fire-box rise to the highest possible point, are usually less efficient than the top rows, and are liable to obstruction through soot and ashes. The result has been, I believe, an increase of evaporative efficiency in the boilers to which this exhaust pipe had been applied, with a corresponding reduction in the coal consumption.

The sanding arrangement is a great improvement on the old method, the sand being blown directly under the tread of the driving wheels by a jet of compressed air. As the engine is fitted with a Westinghouse brake, its pump provides the requisite air, the whole forming a neat and thoroughly scientific sanding apparatus, and when compared with the clumsy plan of dropping large quantities of sand on to the rail in front of the wheel, much of which must be wasted, added to the fact that the engine must move some distance, short though it is, before it gets on to the sand, the advantages are obvious and need no comment. The consumption of sand with the new arrangement is, I believe, only about 1lb. per mile. When no compressed air is available for blowing the sand under the wheels, a steam pipe from the boiler answers the same purpose, this being Messrs. Gresham and Holt's patent, which is now being very generally adopted on English railways. While speaking of sanding for increasing the adhesion, I may mention that on the Belgian State Railways a jet of hot water from the boiler has been used with success. The advantages claimed for this over sanding are that the rails and tires are not worn, and the resistance of the train is not increased as when sand is used.

The following particulars of this engine may also be of interest : The eccentrics are kept in place on the crank axle by lips fitting on to the crank webs, instead of by cutting keyways in the axle. The expansion link is suspended from the centre of its length, which gives much the best distribution of steam (with very little slip of the block) for the Stephenson's link when properly worked out. The fire grate is slightly inclined ; this not only gives a ready access to the hind mud plugs, but also causes the fuel, if put in under the fire-door, to shake itself slowly down to the tube plate end of the box whilst it is being consumed. The effect of this is that the hottest part of the fire is at the tube plate end, and catches the unconsumed particles of carbon from the " green fire " at the back, which would otherwise escape in the form of black smoke. A self-stoking fire is thus to some extent obtained, and a more perfect combustion is the result. The fire-box is stayed on the Belphaire system, and suitable arrangement is made for allowing the copper box to expand, which is very necessary. Longitudinal stays, having expansion joints, are provided between the smoke-box and fire-box tube plates ; this is somewhat uncommon, as they take up room where tubes are the most efficient. The safety valve is of the Ramsbottom type, and is placed on the dome top. This does not seem to me the best possible position, the regulator pipe being immediately below, which will cause a current to be formed in the steam at this point, while the object should be to get the steam as still as possible in the neighbourhood of the valves.

FIG. 2.



Practical Engineer.

Heating Surface: Tubes, 973 sq. ft.; Box, 112 sq. ft.; Total, 1,085 sq. ft.; Grate Area, 17·4 sq. ft.

The locomotive shown in fig. 3 is perhaps one of the most celebrated in the world, and that it is that takes the East Coast express on the first part of its journey. It is the design of Mr. P. Stirling, of the Great Northern Railway, being one of the most recent developments of the single driving wheel express engine.

The cylinders are outside, and are 18in. diameter by 28in. stroke, which, with an 8ft. driving wheel (taking the tire as half worn), gives a tractive effort of 94½lb. per pound of cylinder pressure. The front end of the engine is carried on a bogie having four wheels 3ft. 11in. diameter, and the trailing wheels are 4ft. 7½in. diameter. It will be noticed that the bogie centre pivot is not placed midway between the axles, it being 3ft. 6in. behind the leading and only 3ft. in front of the trailing bogie axle. The effect of this is to unequally distribute the weight on the wheels, and it is claimed for this arrangement that the leading wheels, being more in advance of the engine than if pivoted centrally, take the curves with greater freedom, and also that the hind wheels have less side movement towards the outer rail; thus the guiding of the engine is eased.

The distribution of the weight on the rails is :—

On the leading bogie wheels	17 tons 11 cwt.	8 tons 2 cwt.
„ hind „		9 „ 9 „
„ driving wheels		17 „ 0 „
„ trailing „		10 „ 12 „
Total		45 tons 3 cwt.

Mr. Stirling himself says, in speaking of the weights on the rails of this locomotive, "that the bogie carries a comparatively light weight on each wheel, but sufficient to solidify the road before the driving wheels come on to the rails, and thereby put them in the best position to carry the weight on the large wheels, while the load on the trailers holds down the rails behind." Thus a long and comparatively steady bed is made for the engine. He adds that the engine has plenty of adhesion for the size and power of the cylinders, and does not slip more than coupled engines.

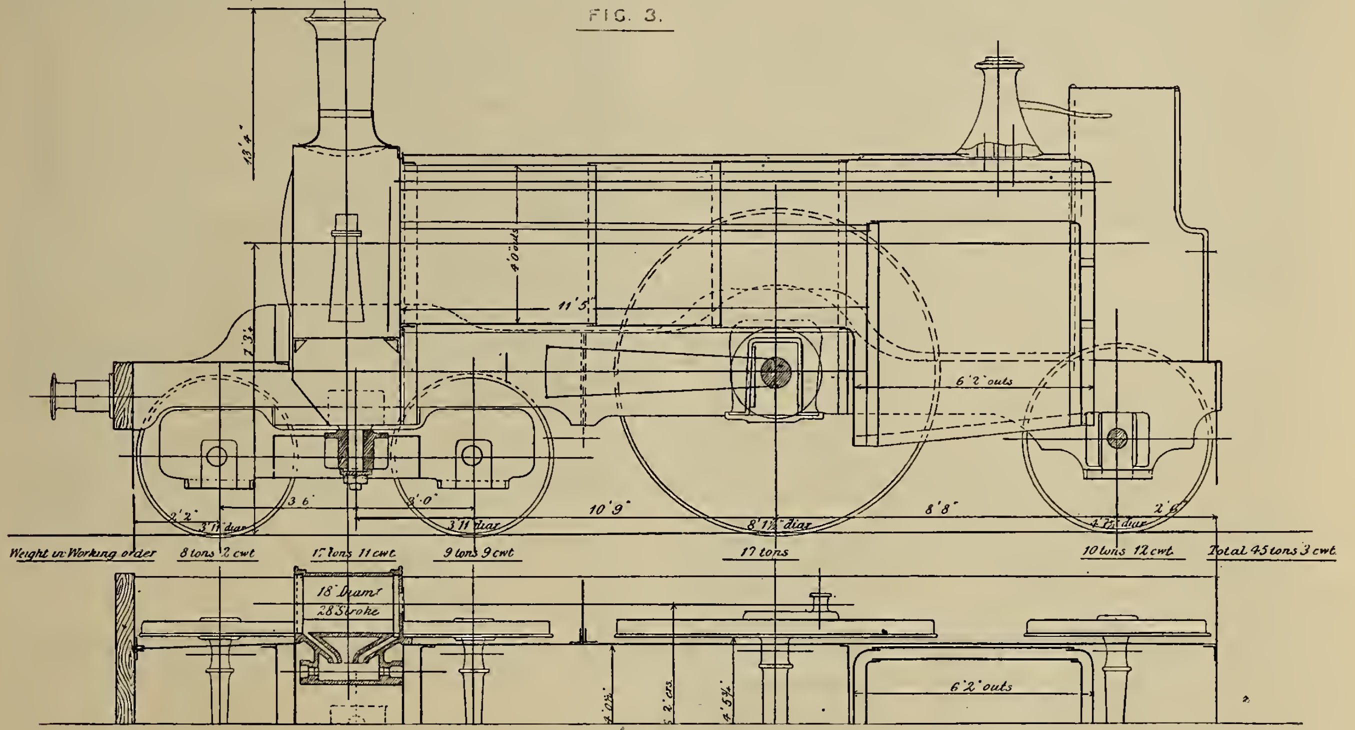
The boiler is 4ft. diameter, its heating surface being, in the firebox 109 square feet, and in the tubes 936 square feet, making a total of 1,045 square feet; the grate area 17¾ square feet, and the boiler pressure 140lb. per square inch. The diameter of the boiler seems small for this size of engine, but is a necessity owing to the driving wheels being higher than the boiler centre line above the rails. As it is, the clothing has had to be cut away behind the driving splashers. Mr. Stirling does not employ a dome on his boiler, using instead the Hawthorn collecting pipe. The absence of the dome certainly adds to the appearance of the engine and also to the strength of the boiler. Still it seems to me that with outside cylinders, which require the driest of steam, a dome would be of advantage, and I believe that the cylinders of these engines require very careful watching, or the consequence would be the forcible removal of a cylinder cover. Another objection to the absence of a dome is that the dome serves as a very efficient manhole, through which the state of the stays may be periodically inspected.

The tender has six wheels, 4ft. 1½in. diameter, carrying 2,900 gallons of water and 5 tons of coal, weighing, when full, 33½ tons, the water supply being sufficient for a run of 105 miles without a stop.

The engines of a similar type which preceded this, having, however, more heating surface, travel between King's Cross and Leeds, the gradient out of Leeds being 1 in 50, and leaving King's Cross 1 in 105. It is said that trains of from 16 to 20 carriages are taken with ease, and that the engine is capable of moving a gross weight of engine, tender, and train of 356 tons on a level at a speed of 45 miles an hour; the steam pressure being 140lb., and with trains averaging 16 coaches of from 10 to 12 tons each, the consumption of coal has been 27lb. per mile.

(To be continued.)

FIG. 3.



Practical Engineer.

Heating Surface: Tubes, 936 sq. ft.; Box, 109 sq. ft.; Total, 1,045 sq. ft.; Grate Area, 17¾ sq. ft.

ALLOYS: THEIR CONSTITUTION AND PROPERTIES.—VI.

(*Continued from page 615.*)

We have seen allotropic states produced in metals by their release from their amalgams, and from alloys with each other, and I have given you evidence of polymerisation induced by the act of alloying metals. We have just examined a case in which simple elevation of temperature is sufficient to cause molecular change in an alloy. There is, therefore, firm experimental basis for the view to which Matthiessen was guided, nearly thirty years ago, by a study of the electrical resistance of solid alloys, that when metals are united to form alloys, in many cases one metal, and sometimes both metals, assume the allotropic state. He showed, for instance, that silver has a conductivity represented by 100; the addition of a small quantity of gold to the silver is attended with a rapid fall in the conducting power. The conductivity of pure copper may be represented by the number 98; the addition of a small portion of tin greatly diminishes the conductivity, as is proved by the curves given in the last lecture. He points out that the amount of tin is too small to admit of the possibility of a chemical compound being formed, and from this fact and other evidence he concludes that the passage to an allotropic state can alone explain the result. This leads me to speak of the influence of small quantities of one element on large masses of another. You may say, Does it matter after all? Grant that a metal may assume an allotropic state in virtue of the presence of a small quantity of foreign matter hidden in it: is the mass any the worse or better—are its physical or mechanical properties greatly modified? Submarine telegraphy will present us with the first case. It may sound strange, but the commercial success of a submarine cable is measured by the speed with which messages can be sent through it, and upon this point we have the testimony of Mr. Preece, who tells us that a cable made of the copper of to-day, when the necessity for employing pure copper is recognised, will carry twice the number of messages that a similar cable of less pure copper would, in 1858, when the influence of impurities in increasing the electrical resistance of copper was not understood. A paper by Sir W. Thomson shows how important the purity of copper is, and how obscure is the mode of action of the impurity. I believe it is safe to say that the presence of $\frac{1}{10}$ per cent of bismuth in the copper would, by reducing its conductivity, be fatal to the commercial success of the cable.

The influence of small quantities of foreign matter is more marked in the case of iron. Steel differs from iron, as you know, by containing a small quantity of carbon. If you introduce into the iron $\frac{2}{10}$ths per cent by weight of carbon, you produce a material which would make an excellent bridge or a boiler plate, but if fashioned into a weapon would be absolutely untrustworthy, for it would bend, as this worthless sword did, when very moderate demands were made upon it. On the other hand, if you introduce $\frac{8}{10}$ths per cent of carbon, you obtain a material from which a good razor might be made; but it would be useless for a rail, or for the construction of a bridge.

I will now appeal to gold. The addition of $\frac{2}{10}$ths per cent by weight of bismuth would, from the point of view of coinage, convert the gold into a useless material, which would crumble under the pressure exerted through the die. Instances of a similar nature might be multiplied indefinitely. I will only quote a statement of Sir Hussey Vivian, who says that $\frac{1}{1000}$th part of antimony will convert best select copper into the worst conceivable. Here is a sample of the alloy called "yellow metal," which would certainly have been condemned, because its fracture affords evidence of the presence of the $\frac{1}{10000}$th part of antimony, which is found to prejudice the working properties of the alloy.

Is it possible to explain facts such as these? We have seen that comparatively slight variations in external conditions can affect the atomic arrangement of metals, and we must now ascertain what relations may subsist between the atoms of the mass of metal and the atoms of the added impurity. First, as regards the cohesion of a metal, this property may be investigated by the aid of heat, or by submitting the metal to mechanical stress; and in a research to which I have devoted much time, I selected tenacity as the property to be tested, with a view to ascertain the effect of the added matter upon a metal or alloy when an attempt is made to pull the metal asunder in an ordinary testing machine. Gold was chosen as the subject of the experiment for the following reasons: First, it is a metal which it is possible to purify in a very high degree; it is not liable to oxidation; and the accuracy of the results is not affected by the presence of occluded gases. The purest gold has a tenacity of 7 tons to the square inch, and it elongates about 25 per cent before breaking. Standard gold, which contains over 91 per cent of gold, the alloying metal being copper, has a tensile strength of 18 tons per square inch, and it stretches 30 per cent before breaking; in fact, when an eminent engineer saw the results of these tests, he expressed an opinion as to the possibility of making a very good gun of standard gold, if the cost of the material were no object. When, however, a small quantity of certain metals, $\frac{1}{100}$th, $\frac{1}{10}$th, or $\frac{2}{10}$ths per cent be added to the gold, the cohesion of the metal is reduced in a very remarkable way, as Hatchett showed to be the case in 1803. This bar contains 100 sovereigns melted with $\frac{1}{10}$th per cent of lead; you see that its cohesion is reduced to a very low point, for it is as brittle as can be. I have tried the effect of adding to pure gold other metals and metalloids than lead, introducing in each case as nearly $\frac{2}{10}$ths per cent of the purity as possible. Some of these elements reduced the tenacity and extensibility of gold to a very low point, while others increased one or both of these properties. I will now attempt to give an explanation of these facts. Since 1826, when Gmelin called attention to the relations betwen the atomic weight of elements which have similar properties, chemists have been actively engaged in establishing analogies between the properties of the elements and in arranging them systematically, and the result has been (mainly through the labours of Newlands, Mendeléef, and Lothar Meyer) the promulgation of the Periodic law. This law states that the properties of the elements are a periodic function of their atomic weights. Lothar Meyer has gone further, and has shown that a remarkable relation exists between the atomic volumes of the elements. Now, however tiny the atoms may be, they must possess volume, and the volume of each element will be peculiar to itself. The space occupied by the atomic volume cannot be measured absolutely, but relative measurements may be obtained "by taking such quantities of the elements as are proportional to their atomic weights, and comparing the space occupied by these quantities." The relative atomic volumes of the elements are found by dividing the atomic weights of the elements by their specific gravities. The atomic weight of gold is 196·2; $\frac{196\cdot2}{19\cdot3} = 10\cdot2$, the atomic volume, or, pressed in the metric system, 196·2 grammes of gold would occupy a space of 10·2 cubic centimetres. Lead, on the other hand, would have the large atomic volume of 18·1, and potassium that of 45·1. The question now arises, Does the power to produce fragility, which we have seen certain elements to possess, correspond to any other property of metals with which they may be classified? The facts represented in the Periodic law were in 1869 graphically represented by Lothar Meyer in his well-known curve of the elements. By adopting atomic weights and atomic volumes as co-ordinates, he showed that the elements can be arranged in a curve representing a series of loops, the highest points of which are occupied by cæsium, rubidium, potassium, sodium, and lithium, whilst the metals which are most useful for industrial purposes occupy the lower portions of the several ops.

An examination of the results I have hitherto obtained shows that not a single metal or metalloid which occupies a position at the base of either of the loops of Lothar Meyer's curve diminishes the tenacity of gold. On the other hand, the fact is clearly brought out that metals which render gold fragile all occupy high positions on the curve. This would appear to show that there is some relation between the influence exerted by the metallic and other impurities, and either their atomic weights or their atomic volumes. It seems hardly probable that it is due to atomic weight, because copper, with an atomic weight of 63·2, has nearly the same influence on the tenacity of pure gold as rhodium, with an atomic weight of 104, or as aluminum, the atomic weight of which is 27·0. It will be evident from the table furnished which embodies the results of my experiments, that metals which diminish the tenacity and extensibility of gold have high atomic volumes, while those which increase these properties have either the same atomic value as gold, or a lower one. Further, silver has the same atomic value as gold, 10·2, and its presence in small quantities has very little influence one way or the other on the tenacity or extensibility of gold.

Several of the elements, the action of which has been examined, occupy somewhat abnormal positions, and the reason for this remains to be explained. I hesitate to attempt to offer any mechanical theory to account for the action of the elements, but it may perhaps be well to refer to these spheres as affording a rough indication of what may take place. If five spheres, representing atoms of a certain volume, are arranged so as to touch each other, it will be evident that the addition of an element with a small atomic volume may improve the tenacity by filling up the central space which would otherwise remain void; with such an arrangement of five atoms the addition of an element with the same atomic volume as themselves will tend to drive them slightly further asunder, and should, therefore, act prejudicially in a five-atom group, although it would exactly fill the space between a six-atom group, but in either case the insertion of a larger atomic volume than that of each member of the group must tend to drive the members of either the five or six atom group further asunder, and by so doing would diminish the cohesion of the mass. No doubt, in some cases, condensation takes place, and this may explain some of the abnormal results.

Name of Added Element.	Tensile Strength Tons per square inch.	Elongation, per cent (on three inches)	Impurity, per cent.	Atomic Volume of Impurity.
Potassium	Less than 0·5	Not perceptible	Less than 0·2	45·1
Bismuth	0·5 (about)	,,	0·210	20·9
Tellurium......	3·88	,,	0·186	20·5
Lead	4·17	4·9	0·240	18·0
Thallium	6·21	8·6	0·193	17·2
Tin	6·21	12·3	0·196	16·2
Antimony......	6·0 (about)	qy.	0·203	17·9
Cadmium......	6·88	44·0	0·202	12·9
Silver..........	7 10	33·3	0·200	10·1
Palladium	7·10	32·6	0·205	9·4
Zinc	7·54	28·4	0·205	9·1
Rhodium	7·76	25·0	0·21 (about)	8·4
Manganese	7·99	29·7	0·207	6·8
Indium........	7·99	26·5	0·290	15·3
Copper	8·22	43·5	0·193	7·0
Lithium	8·87	21·0	0·201	11
Aluminium	8·87	25·5	0·186	10·

Questions of great industrial interest present themselves, especially in connection with iron. With regard to this metal, the evidence as to the action of other elements upon it would appear to tend in the same direction as in the case of gold, although the question is greatly complicated by the relations of iron to oxygen, and by the presence of occluded gases. It may be sufficient for the present to point out that the atomic volume of iron is 7 ; carbon, the atomic volume of which is small, when present in quantities varying from 0·2 to 1 per cent, improves its tenacity. Silicon, notwithstanding its large atomic volume, 11·1, appears to improve the tenacity of iron, although little is as yet known concerning its influence in small quantities. Sulphur and phosphorus, on the other hand, have the large atomic volumes of 15·4 and 14·8 respectively, and both these elements have, as is well known, a highly prejudicial effect on the qualities of iron. Take the case of arsenic, which has an atomic volume of 13·3. One of my own students, Mr. Harbord, has recently read a paper before the Iron and Steel Institute, in which he shows that the effect of the presence of $\frac{2}{10}$ths per cent of arsenic is very prejudicial to iron.

We do not as yet know what is the effect of manganese on absolutely pure iron, but in the simultaneous presence of carbon its influence is most remarkable. You cannot make a magnet out of iron which contains a certain amount of manganese. Its atomic volume is the same as that of iron, and therefore it ought not to act prejudicially on the tenacity of iron, and I think I am safe in saying that it does not. But with regard to permeability of iron to magnetism, the manganese has a remarkable effect, for, as Dr. Hopkinson tells us, "manganese enters into that which must be regarded for magnetic purposes as the molecule of iron, and annihilates the magnetic properties of iron." I could have wished for no better evidence as to molecular change in metal.

Take again the capacity for being hardened by rapid cooling, which is characteristic of steel, and is due to the carbon the metal contains. Here is a knife of soft steel, which bends readily ; it contains some $\frac{5}{10}$ per cent of carbon ; if it is heated to redness and rapidly cooled, it becomes hard. Here is another knife, containing the same amount of carbon ; heat it to redness, and cool it rapidly; it is softer than it was originally, instead of being harder. This remarkable metal contains manganese in addition to carbon, and the manganese has entirely obliterated the action of the carbon. My last illustration is afforded by chromium. The presence of chromium in iron, together with carbon, confers extraordinary hardness upon this metal. A chromium-steel projectile, 12in. long, fired against the compound armour plates made by some of our most renowned makers, pierced no less than a 16in. armour plate, which it shattered very severely ; and conversely, a chilled iron armour plate containing chromium withstood a one-ton shot from a 17in. Armstrong gun, propelled by over 8 cwt. of powder, and the shot only made a dent 1$\frac{3}{4}$in. deep, a most extraordinary result, when the enormous power of a ton shot so fired is borne in mind. Chromium has the same atomic volume as iron.

(To be continued.)

STAYING FOR END PLATES OF LANCASHIRE BOILER, 8ft. DIAMETER.

We give on page 634 an illustration showing mode of staying for a Lancashire boiler, 8ft. in diameter, and suitable for a working pressure of 100lb. on the square inch. The arrangement adopted in the spacing of the gusset stays, it will be seen, is very similar to that which was shown in the sketches given on page 354 of our issue for July 27th, illustrating the staying for a boiler of similar type, for the same working pressure, but 7ft. 6in. in diameter.

As the general design adopted in the arrangement of the stays was so fully described on that occasion, it is unnecessary for us to traverse the ground again, and we must refer our readers to the previous reference for explanatory details. We may state in conclusion, however, that the arrangement of stays shown in the end views is adopted by the Manchester Steam Users' Association for the staying of the end plates of Lancashire boilers made under its survey.

On page 635 we give a longitudinal view, which will render the disposition of the gussets, as far as their hold upon the cylindrical shell is concerned, a little more intelligible. The dimensions of the shell plates and furnace tube rings are based upon the assumption that the boiler has a length of 30ft., and is made of ten belts of plating, both in the shell and furnace tubes. The flanged seams, however, of the furnace tubes, it will be noticed, are all placed slightly in advance of the ring seams in the shell, in order to avoid any difficulty with regard to the renewal or repair of the shell rivets, should occasion render it necessary. The flanged seams themselves are also placed a little apart from each other for a somewhat similar reason. The longitudinal view will be found a convenient supplement to the general specification which was given in our issue for July 27th.

ELECTRIC LIFTS FOR THE EIFFEL TOWER.*

Two lifts are suspended at the two ends of eight steel cables passing over a pulley, and move up and down in two cylindrical adjacent cages, being kept vertical by the aid of guides. Each lift is divided into three compartments, one over the other. The two upper compartments are designed to hold one hundred passengers ; and the lower compartment contains a dynamo of 25 to 30 H.P., to which the electricity is conveyed by a wire from generators on the ground. The dynamo gives a rotating motion to a truck connected axially with the bottom of the lift, which rolls, by means of four projecting wheels placed radially, along a helicoidal rail winding round the side of the cage. There are two of these helicoidal rails placed slightly further apart than the diameter of the wheels, so that the wheels roll on the top of the lower one when the lift is descending, and revolve on the bottom of the upper one during its ascent. The suspending cables are exactly counterpoised by similar cables, attached to the bottom of both trucks, and rolling round two pulleys below the base of the cages. It is assumed that in practice the utmost in difference between the load of the two lifts will be fifty passengers, or a weight of 3$\frac{1}{5}$ tons, whereas the resistance of the system to motion is calculated at 4 tons, so that the lifts will not be liable to move of themselves ; and though the machines are furnished with a brake, the stopping of the dynamos will stop the lifts. The descending truck, revolving under the action of its dynamo, will draw down its lift, and draw up the other lift, which will be lightened by the action of the dynamo in the truck below it. For a speed of 1$\frac{2}{3}$ft. per second, the power required when the lifts are equally loaded will be 27 H.P. ; when the descending lift has the maximum excess of fifty passengers, it will be 5 H.P., and in the reverse case 48 H.P. Under the ordinary conditions of traction there will always be a space between the lift and its revolving truck ; but if the cable broke, the lift, falling freely on the connecting axle, would overtake the revolving truck, and thereby arrest its rotation, and prevent any further movement, thus securing the safety of the lift in the event of a fracture. A telephone will place the two men working the lifts in communication, so that they can always work in concert. The lift is to take passengers from the second to the third floor of the tower, a vertical height of 492ft., without a stoppage, in about five minutes.

THE DRAPER-HETHERINGTON SPRINKLER.

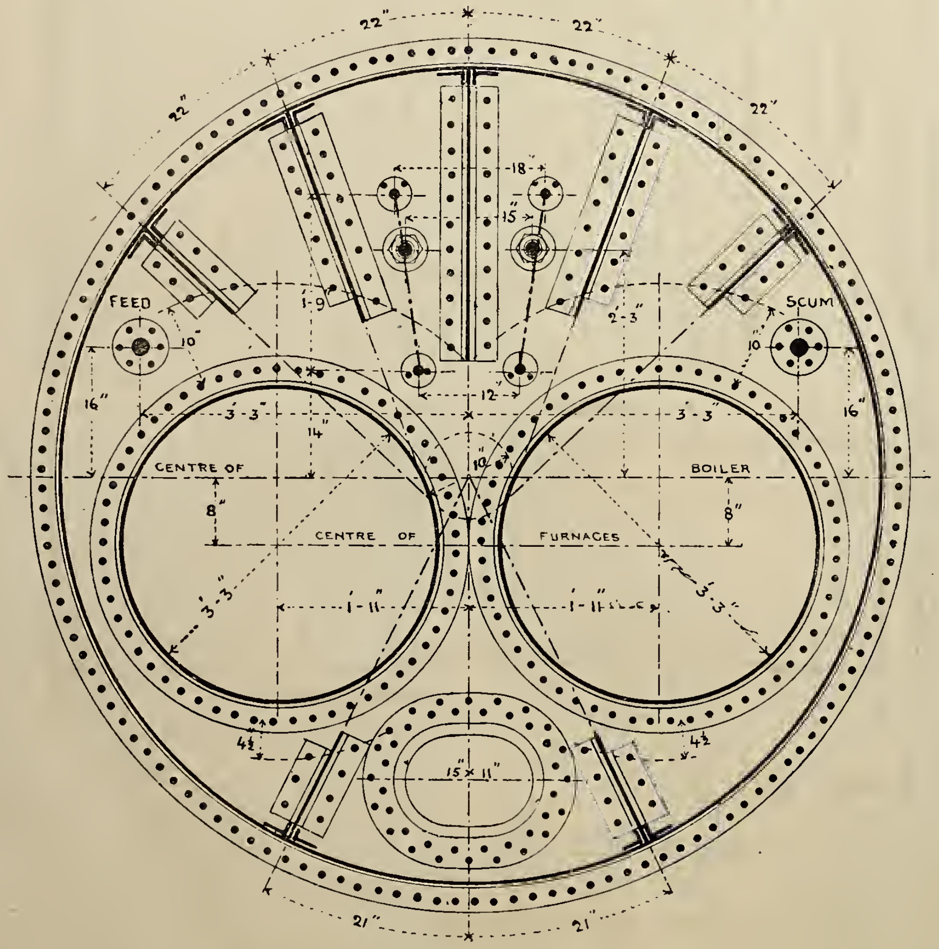
The extinction of fires in the incipient stage by automatic sprinklers has received considerable attention of late owing to the circumstance, among others, that where efficient sprinklers are adopted fire insurance companies reduce their premiums. The latest development in this direction is the Draper-Hetherington sprinkler, which is being introduced by Messrs. Hetherington and Co., of Ancoats Works, Manchester. It is a new departure in this class of fire extinguishers, and the apparatus possesses qualities special to itself, inasmuch as it is brought into operation at a somewhat lower temperature than those which depend for their action upon fusible metal, and after the extinction of the fire it is automatically restored to its normal condition of usefulness, instead of remaining in action until the water is turned off at the main and having to be re-soldered afterwards. In this sprinkler the spindle of the valve which shuts off the water is attached to the concave face of a small metallic cylindrical chamber filled with a mixture of ether and alcohol. On becoming heated the fluid expands rapidly, changes the face of the chamber from concave to convex, and in so doing raises the valve spindle and opens the valve, the water rushing through and being distributed over the seat of the fire. A successful demonstration of this apparatus was recently given at the ropeworks of Messrs. Frost Brothers, at Shadwell. In a building 20ft. long by 12ft. wide and 9ft. high a fire was made with shavings sprinkled with paraffin. In 45 seconds from the time of lighting the fire the sprinklers came into play and rapidly extinguished the flames. After the door had been opened, and when the temperature had been sufficiently lowered, the water was automatically shut off by reason of the contraction of the fluid in the chamber causing the valve to close. Other experiments were tried which proved the automaticity of the sprinklers both in opening and closing. The trials were attended by a number of merchants and others interested in the question of fire extinction.

Foreign Abstracts, Proc. Inst. C.E.

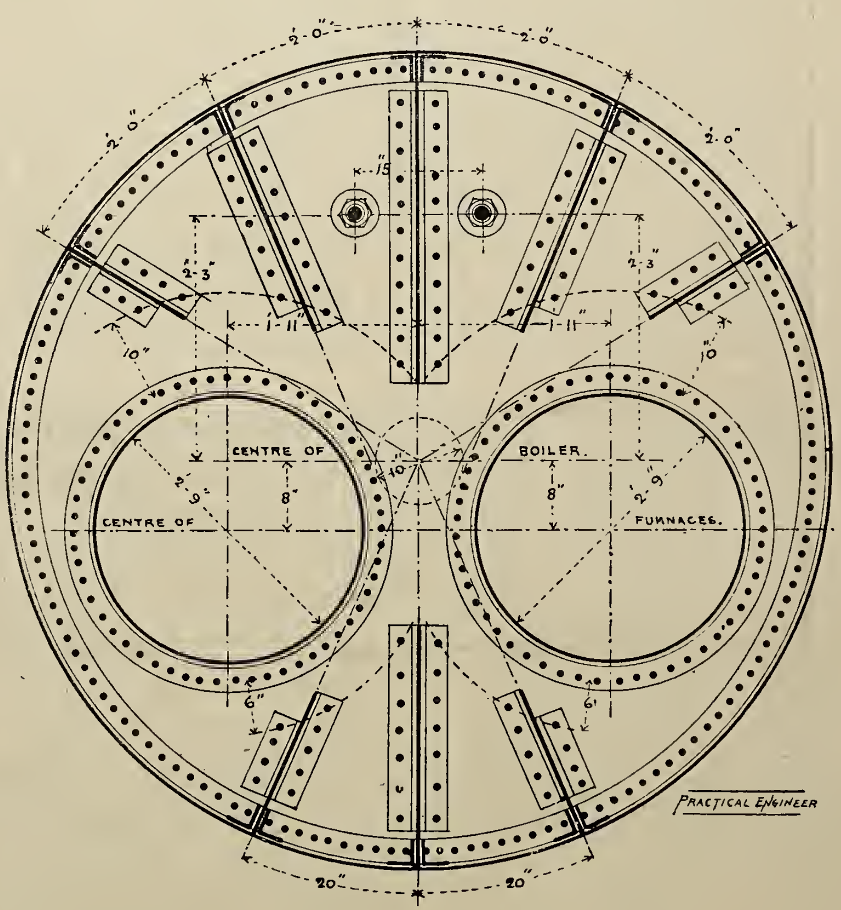
STAYING FOR END PLATES OF LANCASHIRE BOILER, 8ft. Diameter.

WORKING PRESSURE 100lb. PER SQUARE INCH.

(For description see page 633.)



FRONT END.

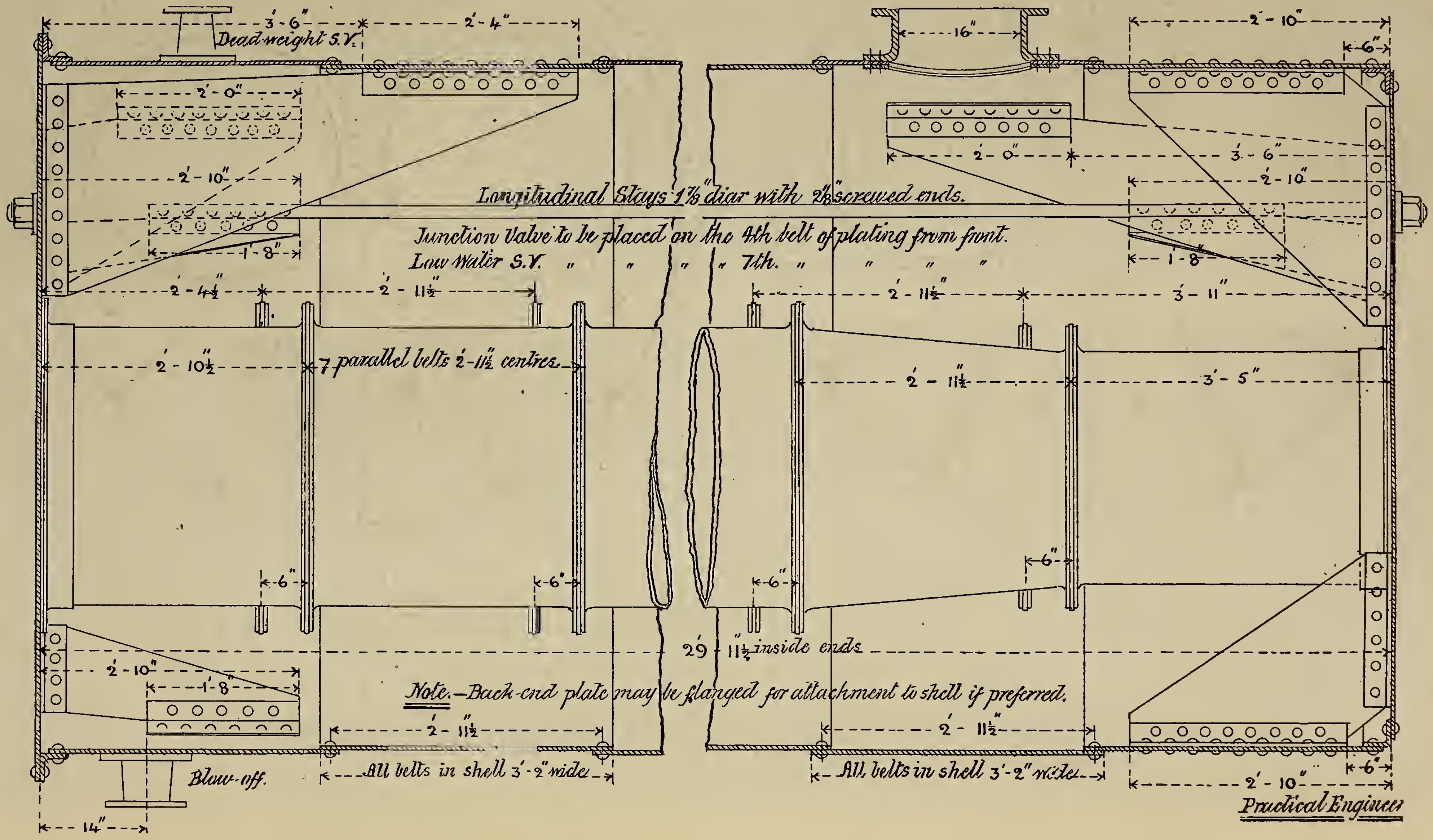


BACK END.

LONGITUDINAL SECTION OF LANCASHIRE BOILER.

WORKING PRESSURE 100lb. PER SQUARE INCH.

(For description see page 633.)


3'-6"
2'-4"
Dead-weight S.V.
2'-0"
2'-10"
1'-8"
2'-4½"
2'-11½"
16"
2'-10"
6"
2'-0"
3'-6"
2'-10"
1'-8"
2'-11½"
3'-11"
Longitudinal Stays 1⅞" diar with 2⅛" screwed ends.
Junction Valve to be placed on the 4th belt of plating from front.
Low Water S.V. " " " " 7th. " " " "
2'-10½"
7 parallel belts 2'-11½" centres.
2'-11½"
3'-5"
6"
6"
6"
6"
29'-11½" inside ends
2'-10"
1'-8"
Note.—Back-end plate may be flanged for attachment to shell if preferred.
2'-11½"
2'-11½"
All belts in shell 3'-2" wide
All belts in shell 3'-2" wide
Blow-off.
14"
2'-10"
6"
Practical Engineer

RECENT IMPROVEMENTS IN OPEN-HEARTH STEEL PRACTICE.*

I.—The Lash Open-hearth Furnace.

This furnace, which is peculiarly adapted to the use of natural gas, is now largely employed at Pittsburg, where twelve furnaces, varying in capacity from 40 to 15 tons, are actually at work, and four others are building. The hearth is made circular, or preferably elliptical in plan, the major and minor axes for a 15-ton furnace, measured within the linings, being 18ft. and 15ft. respectively. It is carried on longitudinal girders at such a height that the charging doors are accessible from the ground level. The retaining shell of $\frac{1}{2}$in. steel plates extends from the top of the side walls down to a broad connecting band below the charging doors, and then slopes inward to the bottom plate of the hearth. The lining is shaped to the shell, and as the bottom plates and supporting girders prevent vertical movement downwards, and the conical shape of the outer walls checks the outward movement due to the expansion of the lining, the rupture of the lower side walls is prevented. The ports are large plain flues 5ft. wide, inclined downwards to the left, at a slope of 4in. to the foot. These serve for the admission of heated air, the natural gas being introduced cold by 2in. pipes, sloped parallel to the ports, which are placed near the four corners of the melting chamber. The gas being much lighter than the air, mixes with it in the downward rush to the furnace. The roof, which is strongly domed, as in the newer Siemens construction, springs from a water-bosh made of $\frac{1}{2}$in. steel plates shaped to form a double skew-back between the arch and the port. This bosh is 5ft. long and 1ft. broad in the base, and is stayed at intervals by transverse bars. Although exposed to the full heat of the gases leading from the melting chamber (calculated at 3,000 deg. Fahrenheit), the underside of these water skew-backs is scarcely affected, even after an exposure to a hundred melting heats. The feed-water is supplied by a 1in. pipe at 5lb. pressure, the waste water being scarcely lukewarm. The regenerators, which are intended for heating the air, are two in number. They are long vaulted flues placed behind the furnace, and perpendicular to its larger axis, and contain a series of rectangular passages of a much more open character than the Siemens chequerwork. The air is taken from the ladle pit by a central flue passing under the hearth of the furnace, which connects with the reversing chamber near the base of the stack. At the bottom of the uptake, a depression, or cinder pocket, is provided below the point of junction with the regenerator flue, to catch any cinder, dust, or other matters brought over by the flame, which might otherwise clog the regenerator passages. The capacity of the air regenerators is about 60 per cent greater than that of furnaces using producer gas. Natural gas is supplied in the service mains to the melting furnaces in the vicinity of Pittsburg at a pressure of about 8oz., and this pressure is adjusted to the service pipes by regulators, ordinarily furnished by the gas companies, placed at some suitable place near the connection with the mains. The pressure is regulated by the valves at the larger Lash furnaces, and is only about 1oz., or 1$\frac{1}{2}$in. of water, as the gas goes into the melting furnace. The lighter the pressure, so long as the flow is kept uniform and steady, the better the combustion and the more intense the heat obtained. The tap hole of the melting furnace is placed about level with the ground, the metal being led by an inclined spout, 10ft. long, to the ladle pit. The ladle when filled is lifted and transferred to a semi-circular casting pit, only 4ft. deep, containing the ingot moulds. The front of the furnace is provided with three cranes, which cover the entire area of both pits and the furnace melting chamber, so that, if the latter is provided with a movable roof, large pieces of metal may be charged into the hearth. There are five charging doors, three at the back and two in front, on the tapping side, all being accessible from the floor level. The average time of charging 50,000lb. of material is about twenty-four minutes, twelve hands, the entire working force about the furnace, doing the charging from all five doors, which are balanced and arranged to open by levers on the pulpit, under the control of the crane-boy. The rapidity with which repairs can be made upon Lash furnaces is one of their most important advantages. A 30-ton furnace was repaired, the bottom taken out, and the brickwork, from the ground level up, entirely renewed, in a fortnight, counting from heat to heat. A furnace of the same size has also had the entire lining of the melting chamber, from the hearth up, and the side walls of the flues leading to the downtakes, rebuilt in five days from heat to heat, or from Saturday to Thursday. The cost for repairs per ton of steel ingots in the 40-ton furnace varies from 13 to 20 cents per ton.

II.—A New Direct Method of Making Wrought Iron.

The Carbon Iron Company, of Pittsburg, has developed a new reducing process for making wrought iron from the ore, which, with the exception of the Hushavel* process, is about the only one which has been successful. This is based upon the use of a peculiar variety of graphite as a reducing agent, which also protects the reduced iron from reoxidation. This substance, which is got from Cranston, near Providence, Rhode Island, resembles both graphite and anthracite, and is of the following average composition:—

Graphitic carbon	78
Volatile matter	2
Silica	15
Phosphorus	0·045

This was formerly worked as a coal, but it was found that it would only burn with extreme difficulty. In the new process it is mixed with the ore, both being ground fine enough to pass through a sieve of sixteen meshes to the inch, and mixed with water so that the mass may be easily moulded by the hand. The proportions adopted are 5 cwt. of graphite to 20 cwt. of ore, the latter being a pure specular ore from Minnesota, containing 62 per cent of iron. The mixture is placed upon a large flat hearth measuring about 22ft. by 5ft., with a stack in the centre of the furnace. The depth of the charge is about 4in., over the entire furnace bottom, which is simply a bed of graphite, 8in. deep, laid upon the brickwork. The doors are well luted to prevent ingress of air, and a reducing flame of natural gas is allowed to play over the hearth from jets at both ends of the furnace. In about twenty minutes the mass has diminished to about one-half in thickness, and blue flames of carbonic oxide are evolved from all parts of the surface, the temperature being about 1,000 deg. Fahrenheit. At the end of an hour the charge has still further shrunk to one-third, and beads of iron are seen all over the surface. The reducing heat is kept up in the furnace for half an hour more, when the balling work commences in the ordinary way, as in puddling. The iron is easily made up into balls of 100lb. to 150lb., each one being rolled to one side while the remainder are being made up. The highest temperature attained is an orange-red heat (about 1,500 deg. Fahrenheit), near the end of the balling period. If the metal is required for open-hearth melting, the heat is never raised to the melting point of cast iron, but if the balls are to be rolled a welding heat is necessary. The reducing flame in the furnace is easily obtained from a 1$\frac{1}{2}$in. pipe supplied with natural gas, at 4oz. pressure, leading into a firebox at either end of the furnace. When the balls are ready, which usually requires about half an hour, they are withdrawn from the furnace to be shingled and rolled into puddle bars or blooms, or preferably they may be taken hot to the bath of an open-hearth furnace. In the latter case the entire operation is finished in two and a quarter hours, but when the puddled bars are made three hours are required. Each furnace will make eight heats of 1,530lb. of sponge balls in 24 hours.

For every 100lb. of Minnesota Y ore, containing 62 per cent of iron, there is a yield of—

	lbs.
Sponge	66·75
Blooms, 6 × 6 × 20 inches	50
Billets, 4 × 4 × 24 inches	45
Puddle balls, $3\frac{1}{2} \times \frac{7}{8}$ inches	42·50

In the last case the loss is about 29·7 per cent of the iron in the ore. When the charge is converted into open-hearth steel, the loss is 12·9 per cent.

Drilling Wells in China.—The French Abbé Hue thus describes the system of deep earth boring practised in the district in which he for some time resided. A wooden tube 6ft. in length is first driven down through the surface soil. This tube is held at the surface of the ground by a large flagstone, having a hole in the centre to allow the tube to pass through, and to project a little above it. A cylindrical mass of iron, weighing about 400lb., hollow and pointed at its lower end, and having lateral notches or apertures, is jerked up and down in this tube at the end of a lever, from which it is suspended by a rope. This kind of "monkey" disintegrates the rock, the débris of which, converted into sludge by water poured in, finds its way through the lateral apertures into the interior of the cylinder. By raising the latter at intervals, this sludge is removed from the borehole. The rate of boring in rock of ordinary hardness is 1ft. in 12 hours. Only one man is employed at a time to work the lever. By this means wells of 1,800ft. deep are sunk in about two years by the labour of three men, relieving one another every six hours.

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* Paper by A. E. Hunt, in Transactions of American Institute of Mining Engineers, from Foreign Abstracts, Proc. Inst. C.E.

* Minutes of Proceedings Inst. C.E., vol. xci., p. 550.

Area per Linear Foot of Tubes. From ¼in. to 14in. External Diameter.

External Diameter.	Surface.	External Diameter.	Surface.	External Diameter.	Surface.	External Diameter.	Surface.	External Diameter.	Surface.	External Diameter.	Surface.
in.	sq. ft.	in.	sq. ft.	in.	sq. ft.	in.	sq. ft.	in.	sq. ft.	in.	sq. ft.
¼	·0654	1 9/16	·4090	3¾	·9816	6⅜	1·668	9	2·355	11⅝	3·043
5/16	·0817	1⅝	·4254	3	1·014	6½	1·701	9⅛	2·388	11¾	3·075
⅜	·0981	1 11/16	·4417	4	1·046	6⅝	1·734	9¼	2·420	11⅞	3·103
7/16	·1145	1¾	·4580	4⅛	1·079	6¾	1·766	9⅜	2·454	12	3·140
½	·1308	1 13/16	·4744	4¼	1·112	6⅞	1·799	9½	2·485	12⅛	3·173
9/16	·1472	1⅞	·4908	4⅜	1·145	7	1·832	9⅝	2·519	12¼	3·206
⅝	·1635	1 15/16	·5071	4½	1·177	7⅛	1·865	9¾	2·552	12⅜	3·239
11/16	·1799	2	·5235	4⅝	1·210	7¼	1·897	9⅞	2·585	12½	3·272
¾	·1963	2⅛	·5562	4¾	1·243	7⅜	1·930	10	2·617	12⅝	3·305
13/16	·2126	2¼	·5890	4⅞	1·275	7½	1·963	10⅛	2·648	12¾	3·337
⅞	·2290	2⅜	·6217	5	1·308	7⅝	1·995	10¼	2·682	12⅞	3·370
15/16	·2454	2½	·6545	5⅛	1·341	7¾	2·028	10⅜	2·714	13	3·403
1	·2617	2⅝	·6871	5¼	1·374	7⅞	2·061	10½	2·748	13⅛	3·435
1 1/16	·2780	2¾	·7199	5⅜	1·406	8	2·094	10⅝	2·780	13¼	3·468
1⅛	·2945	2⅞	·7526	5½	1·439	8⅛	2·126	10¾	2·814	13⅜	3·500
1 3/16	·3108	3	·7853	5⅝	1·472	8¼	2·159	10⅞	2·839	13½	3·534
1¼	·3272	3⅛	·8180	5¾	1·505	8⅜	2·192	11	2·879	13⅝	3·566
1 5/16	·3435	3¼	·8508	5⅞	1·537	8½	2·225	11⅛	2·912	13¾	3·599
1⅜	·3597	3⅜	·8833	6	1·570	8⅝	2·257	11¼	2·945	13⅞	3·631
1 7/16	·3762	3½	·9158	6⅛	1·603	8¾	2·290	11⅜	2·977	14	3·665
1½	·3926	3⅝	·9483	6¼	1·635	8⅞	2·323	11½	3·010		

SURFACE OF TUBES IN SQUARE FEET PER LINEAR FOOT.

The table above will be found useful for rapidly calculating the heating surface of locomotive and other tubular boilers, for working out the cooling surface of surface condensers, or for estimating the heating surfaces of uptakes and cross-tubes of vertical boilers. We are not aware that such a complete table appears in any engineering handbook. In some cases a few sizes are given, but it often happens that the one required is omitted. The present table, which the writer has used during a lengthy drawing-office career, and found it to save an immense amount of labour where calculations are frequently required, will be found sufficiently comprehensive for all practical purposes.

RAWLINSON'S PATENT TOOL HOLDER.

We illustrate on page 638 two improved forms of tool holders, made by Messrs. Kendall and Gent, of Manchester, which are claimed to be improvements on other types, both in the method of holding the steel when cutting and in the facility for changing the tool.

The great advantages arising from the use of tool holders over ordinary forged tools, both on the score of economy and efficiency, are too apparent to require dilating upon. Figs. 1 and 2 show a pair of Rawlinson's patent tool holders (one right hand and one left) adapted for holding round steel cutters—a set of which is shown in fig. 3. The method generally adopted of holding round steel cutters has been by means of set screws or wedges driven down the back, and the objection to either of these plans is that it often results, after a time, in fracturing the holder on the thin side opposite to the set screw or wedge.

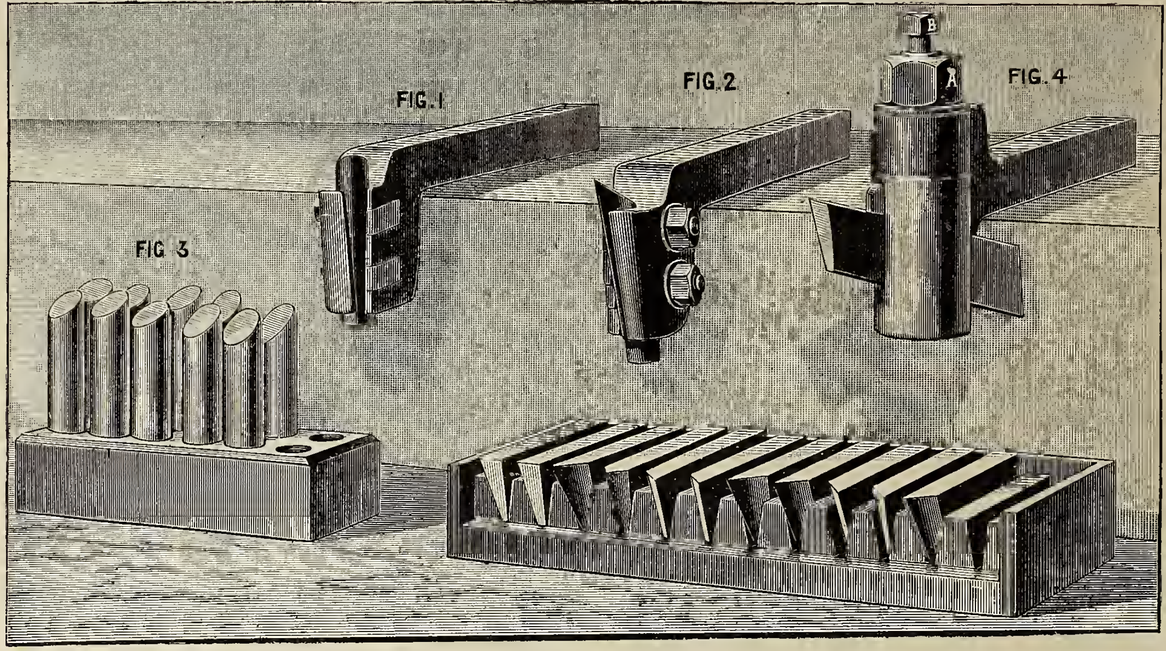
In the improved holders, shown in the illustration, it will be seen that the steel is gripped firmly against the shank of the holder by two bolts, which can be instantly fixed or withdrawn. In this arrangement the only part which is liable to break is the bolt, and should this occur, which is not often, the bolt can be easily and quickly replaced; whereas in the older types the holder, in the event of fracture, is rendered entirely useless.

Fig. 4 shows an improved arrangement of swivel tool holder, in which the tool when worn can be instantly changed without unsetting the angle to which it may have been set to suit the work. Fig. 6 shows a set of cutters for same. These cutters, it will be seen, are arranged for cutting into corners where the round tool is not available, and can be swivelled either to the right or left, according to the nature of the work. The swivelling of the tool is regulated by means of the large nut A, shown on fig. 4, while the smaller screw B, on the top, secures the cutter in the holder. By this contrivance the time required to readjust the position of the swivel, as is necessary with some holders each time a cutter is changed, is entirely saved, while the liability to error in resetting is avoided.

Presentation to South Kensington.—Mr. W. Crookes, F.R.S., has presented to the Department of Science and Art a collection of 68 radiometers and similar instruments for permanent exhibition in the science galleries of the South Kensington Museum. They illustrate the steps by which Mr. Crookes was led to the construction of the radiometer, and to the production of motion and of phosphorescence by streams of electrified molecules in high vacua. Many of the instruments are of the greatest historical interest. Among them is included the first radiometer, with many others which are described in Mr. Crookes' papers in the "Philosophical Transactions of the Royal Society." Others are of considerable value, as they contain collections of diamonds, rubies, &c., for the exhibition of the phenomena of phosphorescence. Nearly all are in working order, and will be of great use in illustrating lectures to students in the Normal School of Science at South Kensington.

RAWLINSON'S PATENT TOOL HOLDER.

(For description see page 637.)



ILLUSTRATIONS OF THE USE OF THEORY IN THE WORK OF THE ENGINEER.*—I.

The name of your society suggests to me that I may venture to speak to you as an older to younger engineers. You, I doubt not, like the scientific and honourable profession into which you have entered, and look forward to accomplishing many things. I began work as an engineer more than thirty years ago, and must look back on such work as is already done as the greater part of what I can hope to do. You can hardly imagine with what scanty means of attacking the problems before us we were provided thirty years ago, in the days before Rankine. I envy you a little the abundant means of acquiring information open to you at an age when the mind is plastic and the memory retentive. You have now a copious technical literature, which every year is becoming more trustworthy and accurate; you have engineering societies, with papers and discussions quite remarkably instructive and interesting, and many of you have had the advantage of systematic technical instruction in colleges provided with laboratories more complete than any we dreamed of thirty years ago. The change in the conditions of entering the profession is a great one and an advantageous one.

Nevertheless it is pleasant to look back and to remember that one saw the birth and development of so many of the processes, the improvement of so many of the machines, the invention of so many of the structures, the use and construction of which is now the ordinary business of the engineer.

Now, nothing is so striking in looking back on the history of engineering during the last thirty, or at most forty years, as the growth in connection with the practice and business of engineering of a body of scientific principles forming a science of engineering. The engineer has in part acquired, in part discovered, the scientific principles applicable to his daily work. Happily for the engineer, scientific men pursuing investigations which had no immediate practical bearing had already gained much of the knowledge necessaary for his purposes. The mathematician, the physicist, and the chemist had provided—or during a century past have been providing—a great amount of knowledge, which the engineer had only to acquire in order to perceive applications of it in practice. That, however, is not the whole story. Purely scientific men, whose experience is confined to the laboratory, are apt to forget that a large part of the work of an engineer is nothing else than experimenting on a very large scale, and, to tell the truth, with very heavy penalties in most cases for failure. Conditions, sometimes of cost, sometimes of safety, compel the engineer to estimate the quantities of materials and the forces at work in practical operations, with an accuracy proportionately as great as the measurements made in purely scientific researches. Such observations and measurements build up portions of science as solidly as laboratory experiments. Unexpected conditions arise as often in practical operations on the large scale as in laboratory researches, and are as likely to lead to discoveries. Purely scientific men sometimes profess to look down on those whose interest in science is connected with practical or commercial applications. If the engineer does indeed look to the Cow of Isis, not as the divine symbol of knowledge, but chiefly for the pounds of butter she will yield, the world at least is the gainer. But, in fact, the engineer is forced to be a scientific investigator by the problems he has to solve, and not seldom his researches extend far beyond immediate practical needs and interests, and are carried on in a spirit as truth-loving and with a zeal as keen as any laboratory investigations.

Researches like those of Darcy and Barzin on the flow of water, like those of Froude on the resistance of ships, like those of Hirn on steam engines, supplemented as these have been by other experiments, among which those of Mr. Mair and Mr. Willans, may be referred to as amongst the most careful and valuable. These are researches suggested by practical needs, and carried out by engineers; but in a spirit as scientific, with an accuracy as great, by methods as elaborate as any purely scientific researches, and on a scale which gives them a special value of their own.

We still hear of an opposition of science and practice. The practical man sometimes calls a more scientific brother a theorist, and the scientific man sometimes retorts that the other is an empiric.

I hope you have read the dissertation prefixed to Rankine's Applied Mechanics on the harmony of science and practice. It is remarkable for insight into the true conditions of practical progress, and for historical knowledge. You may recollect that Rankine traces the idea of an opposition between science and practice in the sphere of mechanics to classical times, and indicates how it hardened into a doctrine amongst mediæval schoolmen. It arose at first in the imperfections of theory, which could not explain ordinary mechanical phenomena, and with the growth of truer views of mechanics in Newton's time it came to be recognised as false. Rankine points out that it subsists still as a prejudice pernicious in its effects both on science and practice.

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* Presidential address by Professor W. C. Unwin, F.R.S., delivered before the Junior Engineering Society, London, October 12th, 1888.

Now, we need not concern ourselves with the scientific men who ignore inconvenient facts because they conflict with their theories; we have to do with practical men who despise theory. Rankine indicates that ignoring scientific principles in practical work has a direct and an indirect ill effect, and that the latter has far wider range of mischief. If an engineer builds a structure which breaks down, that is a mischief, but one of a limited and isolated kind, and the accident itself forces him to avoid a repetition of the blunder. But an engineer who from deficiency of scientific knowledge builds structures which do not break, but which stand, and in which material is clumsily wasted, or designs machines which work indeed, but in which there is a costly and extravagant waste of energy, commits blunders of a more insidious kind. The clients of such an engineer pay heavily for ignorance.

It is quite true that a great deal of engineering work must be mere repetition—a manufacture, in fact. But the original designer, no doubt, used all the science he understood, and any prospect of improvement usually lies in the re-application of scientific principles. It is just the chance of opportunities of this kind which for most engineers makes engineering interesting.

Technical Education.—If you will concede the dependence of practical engineering on a body of scientific principles, forming a theory of engineering, then I want to ask your attention first to the subject of technical education, about which there is now so much discussion, and for which, happily, so much is now being done. I have been connected during nearly twenty years with three great engineering schools, and in various ways have seen a good deal of what has been done in technical education during that time.

Let me recall to you the derivation of the title engineer, which Dr. Pole has quoted from Littré's Dictionary. The term engineer comes from the French verb *s'ingénier*, and this is defined to mean setting one's mind to work in order to succeed. You see it is not manual skill, or even managing or making engines, which initially was taken as the mark of an engineer. An engineer was recognised as a man who worked with his brain, not with his hands. He was not characteristically an artificer or mechanic. For the man whose note was to work with his hands we had another term; he was a wright—a wheelwright, a shipwright, or a millwright.

Of course, in the business of engineering there are engaged a large body of artisans, whose value depends on their skill of hand. They are as necessary to the carrying out of engineering work as the chief engineer himself, and I, for one, have the greatest respect for the work they do. In other trades, I suppose, the same division exists in a more or less explicit and distinct way. That is the distinction between the hand workers and the brain workers, by whose combined labour results are accomplished, but whose functions are distinct.

Most of you may have noticed the two remarkable articles on technical education, by Lord Armstrong and Sir Lyon Playfair. Lord Armstrong writes on "The Vague Cry for Technical Education," and shows a very obvious distrust of some things which are advocated in that name. Sir Lyon Playfair replies that he fails to see to what exactly Lord Armstrong objects, and that he is throwing cold water on efforts beginning to bear useful fruit, and promising to have an influence of the widest kind on national welfare. Both articles agree in so much, that one wonders at first why the one should seem so hostile, the other so friendly, to what in both articles passes under the same name.

Now, even the prejudices of anyone with so wide an experience as Lord Armstrong in a matter about which he must know so much, and in which he has so much direct interest, are worthy of attention.

It is clear that in Lord Armstrong's article he is thinking almost exclusively of the education of the artisan class, of those whose value as workers rests chiefly on their skill of hand. He does refer to the other class in a single sentence, to which I will return presently. But concerning the artisan class, it is further clear that Lord Armstrong is in no way opposed to their general education. He is heartily in sympathy with every effort to improve primary education, to include in it drawing and manual training, and other practical exercises, and to increase facilities for secondary education and science teaching in evening classes. Where Lord Armstrong stops and becomes doubtful or hostile is, I think, clear. It is at attempts to give in school the specific training in handicraft or trade, which hitherto has been gained directly in the shop. I think Lord Armstrong wishes well to any increase of intelligence in workmen, because its indirect value, its influence on character, on social habits, on the chances of advancement in life, are all good. I think he doubts, and am disposed to agree with him, that scientific training will make men better workmen.

There may be some of the smaller trades, such, for instance, as plumbing, where the operations are simple, and the tools few and comparatively inexpensive. Trades of this sort may possibly be taught in properly appointed schools, which are not too expensive to maintain. How far the school training in such cases may with advantage replace apprenticeship in the trade, or supplement it, it remains for experience to show. In decorative trades, such as wood carving, school instruction must, I have no doubt, be a valuable aid both to the workman and the trade. But cases of this sort touch only the fringe of the great mechanical industries of the country. We, who are engineers, can understand very well how impossible it is to train the vast number of fitters, or boiler-makers, or other artisans connected with engineering, anywhere else than where large and heavy actual work is going on.

Sir Lyon Playfair, with all his great knowledge of what is doing in technical education, does not, I think, fairly meet Lord Armstrong on this point. He does not very distinctly keep clear general education and special technical education, nor sufficiently mark the difference between the means necessary for acquiring the skill of hand of the craftsman and those suitable for educating the brain workers, who do the thinking and designing in all constructive industry.

Sir Lyon Playfair says that, in one sense, technical education should begin in the kindergarten and end at the college, for its great object is to teach workmen to observe, to appreciate, and to think. But surely that is a definition not of technical, but of general education, and leaves out altogether handicraft education.

I looked rather carefully through Sir Lyon Playfair's article, and I find that the two special instances he gives of the marked success of technical education, are instances, not of the workmen class, but of the other class, whose business is to do the thinking of industry. One is the case of the son of a manufacturer, whose technical knowledge gained in a dyeing school enabled him to double the output of his father's manufactory. The other is that of an engineering student whose college exercise in bridge designing was so good that he obtained an appointment direct, to do that kind of work in an engineer's works.

When we turn from the workmen class to that other class whose function is to do the thinking, the case is widely different. I do not speak of the chiefs of the profession of engineering, who are responsible for the carrying out of works, as a whole. They find a place for themselves by force of character, or genius, and after years of experience in more subordinate positions. Between them and the workmen class are the young engineers, for whom regular and systematic technical instruction in the strictest sense is needed, and it is through these that advanced scientific teaching may come to have a real and powerful influence on the maintenance of our mechanical superiority, and so on the welfare of the country and of every class in it. It was, and to a great extent is, the custom for a young engineer to spend three or five or more years in the workshop, acquiring hand skill like an artisan. Along with this he has the opportunity of seeing how work is carried on, and understanding engineering tools and appliances. But, however good a school for the workman, the shop is a most imperfect school for the engineer. The value of acquiring handicraft skill in the case of the engineer is easily overrated, and the long time spent in the workshop, involves in one direction a good deal of loss. During years at the bench much of school knowledge of science and mathematics disappears.

Here I return to a point in which I venture to think Lord Armstrong a little underrates the need of college training for engineers. He recognises that it is the class of young engineers who have to do the thinking in engineering works, who will benefit most by college training, but he thinks even they may get on without it with the aid of books. That is quite true, no doubt, but yet no one who has not had, as most of us older engineers had, to get all their theoretical training from books, can realise how very difficult a process that is, and how much determination is wanted before any really difficult theory is mastered. There is plenty of information in books which lies useless to those who most need it, partly because they do not know where to find it, partly because without some help or direction they are unable to understand it when they do find it. Besides this, and more important than this, is the fact that it is not the specific solution of specific and clearly stated problems which is the only use of scientific knowledge to the engineer. The scientific engineer thinks rightly where the problem is not specific, and does not admit of direct solution. He foresees and provides for requirements which are not obvious at first sight, and has the key to facts which, to an untrained mind, would appear insignificant, and be passed over without notice.

(To be continued.)

CORRESPONDENCE.

We do not hold ourselves responsible for the opinions of our Correspondents.

RIVETS AND RIVETING.

To the Editor of "The Practical Engineer."

SIR,—With your kind permission I should like to say a word on the above, and should be pleased to see the matter taken up and discussed by your more able practical subscribers. I have recently seen several specifications for land boilers varying from 80lb. to 120lb. pressure, from 6ft. 6in. to 8ft. in diameter, and from $\frac{3}{8}$in. to $\frac{5}{8}$in. in thickness of shell plates, and in no case is either diameter of rivet or rivet hole given. How is this? Some of them are by eminent engineers, and some are books of many pages; a few give pitch of rivets, but none give diameter. This seems to be left to the discretion of the boiler-maker, while more trifling matters are most minutely described.

Now, I have my own (perhaps peculiar) views as regards rivets, and look upon them as the most important part of the structure, and to leave the diameter of the rivet to the discretion of boiler-makers is, in some cases at least, decidedly wrong and liable to lead to serious errors. Many boiler-makers are still to be found who will insist, whenever possible, on using $\frac{3}{4}$in. rivets for all purposes and thicknesses of plate, from $\frac{5}{16}$in. to $\frac{5}{8}$in., and retain the old stereotyped pitch of 2in. for single, and $2\frac{1}{4}$in. to $2\frac{1}{2}$in. for double riveted seams, their only reason for this being a dread of "getting mixed" with different sized rivets and different pitches.

Even among the high-class boiler-makers very few vary the diameter of the rivet in any one given boiler, although I believe it is occasionally done. In speaking of thickness, I may say I am of opinion that all the end rivets and rivets in tension should be about 7 deg. thicker than the rivets in shear, particularly the gusset rivets in end plates, as it is known to most of your practical readers, that cases of undue straining from overheating of furnaces, urging of fires, variations of temperature, &c., are always first discovered by the leakages at front end rivets. Again, it will be remembered that these end-plate rivets are generally put in by hand, and are not as well upset and closed in as the machine rivets in shell and flues. Rivets put in by hand are often $\frac{3}{16}$in. to $\frac{1}{4}$in. shorter than is required for same thickness of plate for machine riveting. I am of opinion all joint rivets passing through three thicknesses of plate should be at least 5 per cent. thicker than the seam rivets, so as to increase the nip on the plates in proportion to the thickness of the joint; this I know would affect the overlaps, but only very slightly, while a much better job would result.

Another point to which I would like to call attention is the heating of the rivets, in which sufficient care is seldom exercised. They should be heated in a very clean furnace, gas or oil furnaces giving good results, and all oxide cleaned off before inserting the rivet in the hole. To make really first-class work, I am of opinion that the furnace should be so constructed as to heat the rivets as quickly as possible, and every rivet brought from the furnace passed through a fine spray of water, which would instantly remove all oxide and dirt caused by heating, while the heat of the rivet would scarcely be affected. But to put rivets in a furnace by the bagful, allowing them to remain soaking for hours, and then insert them without any attempt at removing the dirt and oxide, is a most reprehensible practice, not sufficiently noticed by foremen or inspectors. How often are people surprised to see what are considered well-closed rivets cut in section, and found not to fill the hole on account of $\frac{1}{32}$in. of oxide and dirt lying between the rivet and the hole? In the quality of the rivet there can be no excuse for using poor material, as the difference in price is so trifling. Again, sufficient care is not exercised in the selection of rivets. Many engineers will have the plates washed with a solution of sal-ammoniac or other mixture, but they never dream of immersing the rivets in a bath of similar solution. It is all very well to have rigid regulations as to tests of rivet iron and steel for bending, twisting, flattening, &c., but taking the ordinary rivet-makers' productions, I feel sure that if 100 rivets were submitted to a bath of sal-ammoniac, or put in a shingling-box for an hour, many of them would be found much reduced in diameter and of very irregular thickness, such as would be refused by an inspector. The tail end of the rivet is another point which scarcely receives that attention it deserves. A perfect rivet should have the tail end perfectly square and flat, as though it had been cut off in the lathe. A rivet with a bevel end can never make as good work as one which is square, while rivets cut shorter in the shears, as occasionally occurs, cannot possibly make good work. This is a long letter, but I think it is justified by the importance of the subject, and trust it will open out a valuable discussion, as the matter is very far from exhausted.—I am, &c., CHALKLINE.

Dec. 12, 1888.

A CORRECTION.

To the Editor of "The Practical Engineer."

SIR,—In my letter regarding "Compound Locomotives," which appeared in your last issue, the calculation of the fuel burnt per square foot of firegrates is by a printer's error given as 25lb. instead of 125lb. I should be glad if you would kindly correct the point.—I am, yours, &c.,

Dec. 18th, 1888. JAMES BOLAS.

CORROSION IN RASTRICK BOILERS.

To the Editor of "The Practical Engineer."

SIR,—I have under my charge a number of Rastrick boilers, heated by waste gases from re-heating furnaces. The water used is fairly good, making but little scale, yet all the boilers are suffering more or less from corrosive pitting internally in vertical bands, some 6in. or 8in. wide, which I find are coincident with the vertical partition walls of brickwork in the external flues. The other parts of the shell are very little affected, and I shall be glad to know whether any of the practical readers of our paper have met with any similar experience.

What I wish to know is why the corrosive wasting should be confined to those surfaces of the plates which are in direct contact with the brick walls, as I should imagine the heat would be less intense there than at any other part. Whilst writing kindly allow me to congratulate you on the improvement in the paper by raising the price and adding 50 per cent more matter. I think it well worth the difference in price, and feel sure it is a step in the right direction.—Yours, &c.

December 13th, 1888. WORKS MANAGER.

MECHANICAL STOKERS AND SMOKE PREVENTION.

To the Editor of "The Practical Engineer."

SIR,—A considerable amount of controversy is at present going on in some of the daily papers, with regard to the questions of smoke abatement and smoke consumers, and a variety of opinions are expressed with regard to the efficiency of the numerous mechanical devices that are now before the public. Many of the writers, however, are evidently persons who have had little or no practical experience in the subject, and it has occurred to me, that if you would kindly consent to open your columns to a discussion of the matter, somewhat similar to that which took place some time ago with regard to economisers, it would result in the bringing out of many useful facts and much valuable information. We should get the opinions of practical engineers with regard to the merits of the various mechanical stokers and smoke consuming apparatus now before the public, and thus ascertain which were the strong and weak points of each. I, amongst many of your numerous readers, feel sure that the discussion would be both profitable and valuable. I may say that we have two mechanical stokers on the boilers under my charge, and when they are working little or no smoke is made. I say nothing, however, about the wear and tear of the apparatus and their steam-generating qualities, leaving that for other pens.—Trusting the matter will be taken up in a proper spirit, I am, &c., W. S. UNSWORTH.

Crumpsall, Dec. 7th, 1888.

TECHNICAL EDUCATION.

To the Editor of "The Practical Engineer."

SIR,—I was pleased to find from the leading article in your issue of the 30th ult. that you support Lord Armstrong's views with regard to the question of technical education. Although only in the ranks of mechanical engineers, yet as one having had from thirty to forty years' experience in the workshop, I may perhaps be permitted to express an opinion on the matter. I cannot help thinking that many of those who set themselves up as authorities on technical education have never put their foot in a workshop, or if they have, it has only been to acquire a superficial knowledge of what is going on, and they little realise how enormously expensive the schemes they so glibly talk about will prove in practice, and how much they will fail to attain the desired object. If many of the advocates of technical education would consider only one branch of the many trades that exist in the country, viz., mechanics, they would realise the difficulties that stand in the way of teaching such a trade in a school, which arises mainly from the fact that in a school a lad has not a definite object of construction, such as an engine or a locomotive, to engage his attention and excite his interest as is the case in a workshop.

There is one defect in our industrial system which is, I think, largely responsible for much of the dissatisfaction that prevails, and that is the inadequate opportunities for promotion which are afforded to those in the ranks. The pith of genius is now lying dormant amongst our artisans, and if we could only devise some means of bringing it out we never need fear foreign competition. At present there is little or no inducement for a workman to divulge any idea of improvement in the machines with which he is connected. I know, of course, it will be said that patents are now easily and cheaply obtained, but when a workman tries to protect himself in this way he finds, to his cost, that the trouble and expense incurred are, as a rule, out of all proportion to the advantages gained, and that even when he is protected himself his patent is far from being a commercial success unless he can exercise a large amount of professional influence. To my mind it would be much more satisfactory to workmen if employers would encourage workmen to seek their confidence in connection with any improvements, and let it be understood that a substantial reward would follow any benefits received. Our industrial supremacy has not been the result of education in technical schools, but, as Lord Armstrong and others have pointed out, has been built up by the energy of its artisans.—I am, &c.,

December 14th, 1888. LOCOMOTIVE.

QUERIES AND REPLIES.

Changing Currents in Dynamo.—I have a series of wound dynamo of the old Gramme type under my charge, working 19 large arc lamps, and I have found lately that both carbons have craters in the ends, showing that the current must have flowed alternately; and, if this be so, the polarity of the machine must have been constantly changing. Can any reader tell me whether this is a common thing or not, and if there is any remedy for it?—T. H.

Answer.—If by "series *of* wound" dynamo you mean "series-wound," I think you must be in error. Such a machine gives continuous currents, and therefore cannot give an alternating current, else it could not excite. Do you not mean the "Gramme alternator" used to supply Jablockoff candles? These *must* be supplied from an alternating circuit. Give further details, and you may get assistance; at present your query is too vague.—G. T. P., Govan.

Electricity.—I have a slight knowledge of electricity, and should be glad if some of your numerous readers would kindly tell me the best work to study in order to extend my knowledge. I should like one to start from the very beginning and lead up to the various formulæ for leads, dynamo, accumulators, &c., and hints for fitting up installations and management of same.—J. P. W.

Answer.—In reply to "J. P. W.," there is, so far as I am aware, no book of the kind he evidently requires. The only way is by wide and varied reading of various books and periodicals on the subject, backed up by theoretical knowledge, and practical, if possible. For accumulators you had best get Sir D. Salomon's "Management of Accumulators:" London, Whittaker. Price 3s. Shall be pleased to assist you further if required. The title of the article in the *English Mechanic* was "Practical Electric Lighting for Amateurs."—G. T. P., Govan.

Answer.—I am not acquainted with a book which would satisfy all the requirements of "J. P. W.'s" query. If, however, he is anxious to obtain a grounding in the elementary principles of electricity, he will find either of the three following works excellent for the purpose: Deschanel's "Elementary Treatise on Natural Philosophy," translated from the French by J. D. Everett (Blackie and Sons); "Magnetism and Electricity," by Guthrie, in the Collins Advanced Series; or "Electricity and Magnetism," by Fleming Jenkins, in the Longmans series of text books. Of these, I think the first named would be the most suitable, as the illustrations are very good, and the various laws and formulæ are fully explained; it consists of three parts, part 3 being the one treating on electricity. For an advanced study of the subject, I would suggest an examination of the various papers which have appeared in the "Proceedings" of the Electrical Society, and periodicals, as the best course to adopt if practicable.—Orion.

Varnish for Papier-Maché Goods.—Would some reader kindly inform me how to make the black varnish that papier-maché goods are coated with? I want it so that it will not peel off the card. How is the glaze put on after the goods are varnished?—J. T. L.

Slide Valve of Hydraulic Engine.—Will some reader kindly inform me which is the best form of slide valve to adopt? The engine makes 20 strokes per minute, and the pressure is 1,000lb. per square inch. I should be glad also to learn what kind of stop valve is generally used for hydraulic cranes.

Engine Piston.—I should be glad if some fellow-reader could give me a word of advice with regard to the following: In one of the engines under my charge the junk ring is about $\frac{1}{16}$in. or $\frac{1}{4}$in. too slack for the cylinder, and the piston rod is bearing heavily on the gland. Would it be any advantage to turn the piston head upside down? as at present it is very hard to keep the asbestos packing which I use for the gland tight.

Electricity and Prevention of Scale in Boilers.—Is electricity of any use in removing scale from steam boilers? We have spare power in our dynamo, and if any subscriber would offer a feasible suggestion, I should be willing to experiment, and give the result for the benefit of your readers. I ought to say that I am entirely ignorant as to whether anything has hitherto been tried in this direction?—E. L. R.

Coalpit Management.—Will some reader be good enough to favour me with the name of the best works on coalpit management, saying by whom published, and what is the price?

Re-cutting and Tempering Taps and Dies.—I should be much obliged if any reader would give me a little information as to the process of softening, re-cutting, and tempering taps and dies.—Boltmaker.

Blacklead Pencil Making Machinery.—Can any reader inform me where to obtain the raw plumbago for making ordinary blacklead pencils, also the mode of manufacturing same, and the name of any makers of pencil machinery?—B. B.

TO CORRESPONDENTS.

W. James.—Unless some special allowance is made in the calculation, the height of the cone for the governor will be the distance marked B in your sketch, and not A. The error you refer to, however, is *one that is very often made.*

To One in a Fix.—We should think the arrangement of the heating apparatus must be radically wrong in some respect, or the difficulty referred to would not have occurred. It would be impossible, however, to give you any advice that would be of real service without personal inspection, which is, of course, out of the question. You had better get some engineering friend to look into the matter personally.

S. Holt.—We hardly feel in a position to advise you, as the subject is somewhat beyond our province. You will see, however, that we have inserted a query with regard to the matter, which may possibly elicit the information you seek.

Water Tank.—From the sketch and dimensions given, it is impossible to tell whether the curved portion of the tank is elliptical or circular. The cubical contents of the tank, however, will be somewhere about 1,400 gallons. Don't you think it is a little unreasonable to expect us to work out arithmetical problems of this description? The information is of no value to anyone but the questioner, and if we answered all the queries of this kind that came before us, we should require to engage a special staff.

Bridge.—The weight upon the bridge will not be affected by anything floating in the water, since the floating body displaces an amount of water equal to its own weight.

MISCELLANEA.

The Vyrnwy Waterworks.—The impounding of the waters of the artificial lake Vyrnwy, in Llanwddyn valley, for the supply of Liverpool, is now in operation. When the works are completed the lake will be four miles in length.

A New Air-ship.—An experimental trial was made on Saturday with Peter C. Campbell's air-ship, at Coney Island, New York. This new form of balloon ascended 500ft., and having been directed at will by the aeronaut, was landed, it is stated, with great accuracy at the place previously agreed upon.

Fire at Messrs. Doulton's Pottery.—On Tuesday, the 11th inst., a most destructive fire occurred at the celebrated pottery belonging to Messrs. Doulton and Co., and situate on the Albert Embankment, London. The fire which commenced in the upper part of the building assumed alarming dimensions, and before it could be subdued destroyed the greater portion of the premises.

A Heavy Coal Contract.—A contract for 70,000 tons of the best steam coal has just been given to a Newcastle firm for shipment to Alexandria. The contract for several years past has gone to Cardiff, and follows one given by the Peninsular and Oriental Company for the shipment of 170,000 tons for their Eastern coaling stations. The high prices of South Wales are, it is said, sending the orders to the north-east coast.

The New Cruiser.—Another cruiser has been added to the effective strength of the Royal Navy by the completion for foreign service of H.M.S. Champion, which has been rearmed and converted into a modern ship of war in Sheerness Dockyard, at a cost of nearly £30,000. Her muzzle-loading guns have been replaced by four 6in. breech-loading guns, eight 5in. breech-loading guns, four quick-firing guns, and two torpedo tubes.

Kingfisher Lubricator.—There was a slight error in the sketch accompanying the notice of this lubricator, which appeared in our issue of the 7th instant. The knob on the top of the steadying pin of the piston was shown in section as if it formed an integral part of the screw cover, whereas it is entirely separate. The knob thus serves as an indicator to show by its distance above the cover, when the latter has been screwed down, that some effective pressure is being exerted by the piston upon the lubricant in the cap.

New Cable between Scotland and Canada.—It is reported that a company of Anglo-Canadian capitalists is being formed to lay a cable from the Straits of Belleisle to Scotland. By way of subsidy the Dominion is expected to contribute the land for the lines from St. Lawrence to the straits. The tender of the Telegraph Construction and Maintenance Company, of London, to lay cables from Halifax to Sable Island for a subsidy of $10,000 for ten years is favourably reported upon.

An American Salt Syndicate.—It is said that the American and Canadian salt producers are being approached with the view to the formation of an American branch of the English Salt Trust. The proposal is to buy their works outright, the owners agreeing not to engage afresh in the manufacture for ten years. Competition is to be prevented by the arrangement of exclusive and favourable terms with the railways upon condition of providing a large traffic.

Work in the Royal Dockyards.—It is stated that the Admiralty have ordered engines to be constructed at Sheerness Dockyard for two new gun vessels, which are to steam twenty-one knots per hour. The engines are to be of triple-expansion type, and of 4,500 horse power. Heretofore machinery for new ships has been supplied by contract, but the Admiralty, believing the work can be done as economically in the royal dockyards, have decided to give the Sheerness workmen a trial. Work has been slack in the engineering department, and the order will avert the necessity of discharging hands.

The Manchester Association of Engineers.—The annual meeting of the Manchester Association of Engineers was held on Saturday, the 8th inst., at the Grand Hotel. Mr. S. Dixon, the retiring president, occupied the chair. Thirteen candidates were admitted members. On the motion of Mr. T. Ashbury, seconded by Mr. Chisholm, Mr. Dixon was unanimously re-elected president of the association. Mr. H. Mainwaring was re-elected treasurer. Mr. Ald. Bailey was elected a trustee in the room of the late Mr. R. Rawlinson, and the retiring trustees were reappointed.

German Weapons and English Workmen.—A crowded meeting of workmen engaged at the Royal Small Arms Factory at Enfield Lock was held on Saturday, the 8th inst. A resolution was passed protesting against the continued employment of German labour to manufacture swords for the British Government, and stating that, as it has been proved that the contractors were importing the bayonets from Germany in an advanced stage of manufacture, after receiving a higher price to manufacture them in England, the contract should be cancelled, and the order given to the Enfield workmen, who are in great distress for want of work.

A Remarkable Steam Voyage.—A remarkable voyage by steam has just been accomplished by the Peninsular and Oriental steamer Arcadia, which left London on the 20th of October for Bombay, where on her arrival she discharged her outward cargo of 3,000 tons and loaded a return freight amounting to 4,000 tons in five working days. Leaving Bombay again on the 17th ult., she delivered her mails at Brindisi and continued her voyage home, calling at Malta and Gibraltar, and arrived at Plymouth at noon on Thursday, Dec. 13th, having performed the round voyage of 13,189 miles in 47 days, including stoppages at the different ports.

A Monster Blast.—A monster blast, by means of mining, took place a few days ago at Furnace Granite Quarry, Lochfyne Side. The mine was bored through the solid rock at a height of 45ft. above the quarry floor. The passage reached a chamber, in which there were deposited upwards of five tons of gunpowder. The chamber measured 7ft. in length, 5ft. in breadth, and 5ft. in height. The whole length of the bored rock measured 114ft., and the height of the rock resting immediately above the chamber was 150ft. The blast was successfully exploded by means of an electric battery, when about 75,000 tons of granite of fairly good quality were displaced. The blast was in all respects a thorough success.

Iron in Burmah.—Dr. Noetling, of the Geological Survey of India, in a recent report on magnetic rock among the Shan Hills of Upper Burmah, describes a mountain or hill at Singaung which "consist of a huge mass of iron ore." Having, he says, noticed on the way numerous pieces of iron ore, which became still more frequent on the southern side of the hill, he examined the latter in several directions. He found the surface everywhere covered with large blocks of iron ore, originating evidently from superficial decomposition of lower beds. He concluded that the whole hill consisted of a large mass of iron ore. He was unable to ascertain the geological conditions under which this ore occurs, or its exact limits and extension, on account of the dense jungle and the tremendous attraction, rendering his compass useless. He estimates, however, that the hill covers at least an area of about a square mile, and that it rises about 200ft. above the level of the Twiunge valley. The ore is hematite-peroxide of iron.

Lloyd's Launch List.—The following is a summary of vessels built under the survey of Lloyd's Register, and reported as launched during the month of November. The details show that fourteen of the vessels, the tonnage of which is given, were above 2,000 tons each. Eight vessels are for foreign owners. The cellular bottom system seems to be growing in favour, many of the steamers being described as having that principle applied. One of the Tyne built vessels is for the carriage of petroleum in bulk, and is built to carry 4,000 tons on a light draught. A Greenock built vessel, for the petroleum trade, is divided into eight oil-tight compartments, and will be fitted with the electric light. The following is the summary for November: Total number of steamers, 39; gross tonnage, 42,819 (plus tonnage of 16, amount not stated). Total number of sailing vessels, 6; gross tonnage, 8,024. In the corresponding month of last year the numbers were: Steamers, 20; gross tonnage, 20,220. Sailing vessels, 2; gross tonnage, 4,250.

A Deep Spring.—A company is at present carrying on works at Seltzer Spring, Spring Avenue, Saratoga, with a view of utilising its waters for the purpose of liberating and storing, in liquid form, the carbonic acid gas which it contains in large quantities. Mr. Oscar Brunler, who is superintending the works, has made a startling discovery in connection with the spring. The latter was discovered about three years ago by Dr. Haskins, who put down the drill to a depth of 500ft. At this depth an abundant supply of water was found flowing from a crevice in the rock bottom. Recently, in order to ascertain the depth of the spring, Mr. Brunler sounded it with a line and plummet; but, instead of resting at 500ft., the weight sank the whole length of the line, 900ft. Other soundings have since been made, the weight used being a piece of 1in. gaspipe filled with lead, and weighing 34lb., until a depth of 3,300ft. has been reached, and yet without touching the bottom or any obstacle. It will be impossible to take further soundings until instruments specially designed for the purpose have been made. Mr. Brunler admits that the line may have been carried away by some powerful current, but he holds to his belief in the existence of a subterranean sea of greater or less extent, and of there being some connection between it and the ocean. In other words, he believes Saratoga is over a vast water-filled cavern, the roof of which is about 500ft. thick.

Crystalline Structure of Glass.—At a meeting of the Manchester Philosophical Society, held the 10th inst., Mr. W. Thomson, in the course of a paper on the crystalline structure developed on ordinary glass by the solvent action of fluorine compounds, stated that when hydrofluoric acid acts on glass, the eroded surface presents a nodular appearance, but when the acid and neutral fluorides act it leaves, especially along the edges of the eroded surface, beautiful six-sided pyramid and cubical crystals. Examined by circularly polarised light, these were observed to possess polarising qualities. As glass in its ordinary condition does not polarise light, it has hitherto been inferred that the flourine compounds combine with the glass and form crystals, believed to be the silico-fluorides of sodium, calcium, or other constituent of the glass. These salts are easily decomposed by sulphuric acid, whereas the crystals in question were not affected by prolonged treatment with both weak and with strong boiling sulphuric acid. Mr. Thomson suggested that glass may be built up of crystals of opposite polarity, the fluorine compounds liberating one of the sets. Mr. Thomson also showed that the bubbles in Prince Rupert's drops are spaces free from air, due to the contraction of the interior of the glass after the surface has solidified. Occasionally Rupert's drops are produced without bubbles, and the force of the explosion when the tail is broken off is then always greater than in similar drops containing bubbles. He described some interesting results obtained after removing the outer surface or skin of the drops.

New Pullman Train between London and Brighton. A special trial trip was made on Monday, the 10th inst., to test a new Pullman train which has been specially constructed for the London, Brighton, and South Coast Railway for their traffic between Victoria and Brighton. The train consists of three cars, each of them being 58ft. in length, 13ft. 2in. in height, and 8ft. 11in. in width. It is continuous throughout, enabling passengers to walk from end to end without any exposure. The first is the parlour car, and is intended to be devoted solely to the use of ladies, and is provided with a boudoir and dressing-room. The second is the buffet car, where light refreshments may be obtained; and the third, which is the smoking car, has capacity for seating 40 passengers. The cars themselves are built on the latest lines, and are lighted throughout with electricity, the necessary power for which is generated by the onward motion of the train, and a sufficient number of accumulators is provided to meet all contingencies that may occur. Every convenience is provided for passengers in the way of lavatories and writing tables, and a small library, consisting of historical and other works, will be provided and placed at their disposal. The platforms which connect the cars are arranged with vestibules, which is done by enclosing the platforms all round with elastic and steel frames, forming a continuous buffer. These frames, when the cars are coupled, join closely together, and are kept in their place by springs forcing them tightly together, making the cars, as it were, into one, and securing wonderful steadiness when running, thus affording security against telescoping in the case of accident.

SELECTED PATENTS.

APPLICATIONS FOR LETTERS PATENT.

December 5th.

17717 Steam Boilers, J. Willis, Sheffield.
17724 Corliss Valve Gears, R. Hargraves, Surrey.
17726 Packing, E. A. Slade, South Shields.
17737 Hydraulic Forging Presses, H. Berry and H. Schlund, London.
17744 Steam Traps, W. Brierley, Halifax. (W. Wilson and J. Sparrow, Quebec.)
17754 Coupling Gear, R. L. Johnson and A. Boots, London.—[Complete Specification.]
17757 Caloric Engine, C. Wells, Middlesex.
17778 Cocks, J. Von Der Poppenburg and C. Budolph, Berlin.

December 6th.

17800 Reheating Steam, S. Eddington and J. E. Steevenson, Chelmsford.
17802 Tubes, F. Holt, Manchester.

December 7th.

17872 Preparing Sectional Steel, J. Dickson, Sheffield.
17881 Metal Arms, J. S. Crowley, Manchester.
17883 Ball Taps, J. H. Wilson and T. Pratt, Keighley.
17884 Fastners, H. Shakeshaft, Manchester.
17889 Steel for Shells, J. Dickson, Sheffield.
17891 Explosive Shells, F. H. Snyder, London.
17900 Coiling Wire Machinery, E. S. Bond and S. W. Johnson, Birmingham.—[Complete Specification.]
17904 Consuming Smoke, J. Willoughby, London.
17905 Rotary Dynamometer, J. Kasalovsky, London.—[Complete Specification.]
17907 Rope Grips, A. J. Boult, Middlesex. (A. K. Evans, Canada.)
17908 Steam-boiler Settings, M. E. Hershey, London.—[Complete Specification.]
17909 Upsetting of Metals, A. J. Boult, Middlesex. (W. Ross and H. D. Bush, Canada.)
17925 Lock Nut, R. Marshall, London.
17927 Electric Steering Indicator, A. C. Boursot, London.
17931 Pumps, H. W. Neild, London.
17932 Dredgers, W. D. Bruce and W. Shapton, London.
17935 Heating Railway Carriages, C. Desouches, London.

December 8th.

17938 Gold Extraction, J. T. Blomfield and W. D. Bohm, Middlesex.
17944 Motive-power Engines, G. C. Dymond, Liverpool. (F. J. Laun, Germany.)—[Complete Specification.]
17956 Steam Boilers, H. Hackey, London.—[Complete Specification.]
17961 Belt Couplings, A. Post, London.
17962 Destructors, J. Wilkinson and J. B. Alliott, London.
17964 Electric Motors, Siemens Brothers and Co., Limited, London. (A. M. Taylor, India.)
17967 Condensing Carding Engines, W. Tatham, Manchester.
17973 Connecting Rod Ends, H. Grafton, London.

December 10th.

17982 Templets, H. J. Macklin, Manchester.
17988 Punching Steel, L. Skinner, South Shields.
17995 Compound Set Square, J. E. Hewison, London.
18008 Getting Coal, W. Walker, London.
18009 Grinding Machinery, C. D. Abel, London. (The firm of O. Dingler and Andres, Germany.)
18020 Crushing Machinery, P. R. Shill, London.
18021 Riveting Machine, J. T. Eltringham and W. Keen, London.
18024 Extraction of Zinc, H. A. Hunicke, London.—[Complete Specification.]

PUBLISHERS' ANNOUNCEMENTS.

BACK NUMBERS of "The Practical Engineer," from the commencement, can be obtained at either of our Offices in London or Manchester, or by order of any Newsagent.

Vol. I. (bound), containing Nos. 1 to 44 inclusive, from March to December, 1887, price 6s. 6d., can still be obtained by order from any Newsagent, or will be forwarded, carriage paid, from either of our offices on receipt of the amount by postal order or stamps.

Numerous complaints having been made to us by Subscribers of the difficulty they experience in obtaining copies of *The Practical Engineer* in certain districts, we have to state that the Journal can be obtained by any Newsagent through the ordinary trade channels, and no difficulty should therefore exist in obtaining copies *by order* of any Newsagent.

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EDITORIAL NOTICES.

All communications for the Editor of this Journal should be addressed to 6, Victoria Station Approach, Manchester.

Communications intended for insertion in the current week's issue should reach us not later than Tuesday Evening.

We cannot undertake to return rejected manuscripts or drawings unless accompanied by a stamped and directed envelope.

Contributors are requested to write on one side only of the paper. Sketches should be sent on separate sheets.

TO ADVERTISERS.

Advertisements intended for insertion in the current issue should reach our Manchester Office on Wednesday Morning *at the latest.*

THE
PRACTICAL ENGINEER.

DECEMBER 28TH, 1888.

THE CONDITIONS OF INDUSTRIAL SUPREMACY.

THE present period of acknowledged improvement in trade is a fitting opportunity to remind ourselves of the conditions which conduce to prosperity, and by which the permanence of such prosperity is reasonably assured. Of course, we know there are people who hold very odd ideas upon this subject, and who variously believe that industrial success is mainly dependent on trades unionism and high wages, non-unionism and low wages, protection and free trade, technical education, party government, and so forth. We do not intend to yield our faith to any of these individual quackeries and nostrums, but simply endeavour to indicate from a matter-of-fact point of view what are the main causes which conduce to industrial supremacy.

In brief, success in trade, like all other success, save that of a forced and abnormal character, illustrates Darwin's exposition of the survival of the fittest, and it follows from adaptation to environment—from harmony with surrounding circumstances and conditions. The law of survival is as inexorable in trade as in vital organisms, and hence fluctuations in trade follow the greatest operations of that law.

Within the memory of all of us certain emigrations and developments of great industries have taken place, which should read us a lesson. Those who are barely in middle life will remember when the great shipbuilding yards and marine engine builders on the banks of the Thames were in the full swing of their activity, reaping the substantial benefits of a world-wide reputation. The bulk of those industries have now migrated to the Clyde, the Tyne, and the Tees. It is not so long since Bristol took rank as the second shipping port in the kingdom, and big manufactures were carried on in the ancient city of merchant princes. She is now, in these respects, but the ghost of her former self, for Liverpool and Glasgow have diverted and absorbed her trade. German and American competition were thought little or nothing of twenty years ago; now, our ubiquitous rivals confront us not only in our own island, but in nearly every foreign mart. Wooden ships have yielded to those of iron, but these are rapidly disappearing before those of steel. Steel rails, steel castings, steel boilers, &c., mark the advance of a new age—the age of steel—which will usurp the place of the iron age. Industries are being modified, or their location changed, and new ones are arising. In all these developments we can, if we trace their causes in detail, observe the survival of the fittest, of that which best accords with the conditions of modern environment.

The development and permanence of an industry in any one locality rather than in another depends on various causes, as the presence of natural advantages, contiguity of raw material, or cost of transit, rate of wages, and so forth. Thus, in the matter of natural advantages, neither Bristol nor Liverpool were originally suitable ports for ocean-going vessels. But while Bristol neglected to dockise the tortuous Avon, Liverpool constructed a series of magnificent docks at almost fabulous cost, and drew the bulk of the ocean trade thither. Even within the memory of living people the Clyde could be crossed on foot at the Broomielaw, at Glasgow. The Barry docks, in the neighbourhood of Cardiff, are the outcome of a determination on the part of that busy port to avoid the blunder of Bristol. Again, the cost of inland transit is so serious an item, that the trade of the inland towns is much menaced thereby. Hence the inception of the Manchester Ship Canal, and of those other schemes for ship canals which are in the embryo condition. For the same reason, some big firms have removed from the inland towns to seaports.

In the iron manufacture we long held what was considered an impregnable position, having our beds of ironstone and the coalfields in such close proximity. But with the advent of the Bessemer steel industry there came a change in the conditions of environment. The utilisation of the phosphoric Cleveland pig was found to be impossible in the acid-lined converter. The only British ores then available were the pure hematites of Cumberland and Lancashire, which were not only costly and inadequate in quantity, but were removed from the localities of the steelworks. Hence a new and promising industry seemed to be threatened with premature extinction; but the mines of Bilbao, in Spain, were destined to be the salvation of the British steel trade, and their ores are now smelted on the banks of the Tyne and the Tees for the Bessemer and open-hearth processes. Going back to 1870, we find that we imported only 400 tons of ore; in 1880, only 3,060 tons; but for the ten months ending 31st Oct., 1888, the Board of Trade returns give 3,121,492 tons of foreign ore imported into Great Britain, having the value of £2,154,105.

It so happens that the wages of the Bilbao miners are very low, 2½d. per hour, or 2s. 6d. per day. If wages were high, as are those of English miners, the cost of the ore would be prohibitory, and our steel industry would suffer in consequence. Here, therefore, low wages are decidedly beneficial to our trade, if not to the Spanish miners. On the other hand, the highest wages are often compatible with abundance of trade—witness our own steel-making industries, iron and steel shipbuilding, our engineers, and those of the United States. These prove that high wages, combined with high skill and modern appliances, will hold their own against lower wages and inferior plant. That starvation wages will not necessarily stimulate trade is seen in the condition of the nailmakers, noticed recently, who, though earning less than the Bilbao miners, are being undersold by Germans.

Returning to steel, steel rails are now made so cheaply (£4 to £5 5s. per ton, according to section), that iron rails are replaced, when worn, by steel. As a set-off against this, the iron shipbuilding has absorbed much of the labour formerly occupied in nailmaking. But in the progress of evolution even that also is doomed. Mr. Parker, chief engineer of Lloyd's Registry, states that by the use of steel ships can now be built to carry 4 per cent more cargo on a consumption of 25 per cent less coal than was possible with the heavier ships of iron. Again, in 1878, Lloyd's Registry contained a total of only 2,682 tons of steel used for steamships; in 1887 they had advanced to 195,907 tons and 14,433 tons for sailing ships. During the last four years Lloyd's surveyors have had submitted to their inspection about 600 steel boilers a year, against one only in 1878. In 1887 the world's make of Bessemer steel was 7,500,918 tons, and of open-hearth steel 1,690,340 tons.* The success of the basic process, by which phosphoric pig is utilised, depends on locality, so that in various districts and countries the question of cost of transit determines the adoption of the acid or the basic methods.

We had intended to make use of other facts illustrative of this subject, but enough has been adduced to show that the only way to secure and to retain industrial supremacy is to conform to the conditions which are deep rooted in universal law. The conditions themselves are clearly beyond our control, but we conquer by ascertaining their character and placing ourselves in harmony with them.

SIR LYON PLAYFAIR ON TECHNICAL EDUCATION.

In distributing the prizes and awards gained by the successful students at the City and Guilds of London Institute, Sir Lyon Playfair, in alluding to the guilds which were founded in the 12th century, said they had a double purpose—first, to protect skilled labour against the encroachment of the feudal laws, the second purpose being more nearly related to that which they were now performing—to restore and develop lost arts and sciences, and to act as teachers to pupils. The word "guild" was a modern innovation. In their ancient charters the guild was called *universitas*—a word which at that time meant a teaching corporation, and it was applied as closely to a university of smiths, or tailors, or carpenters, with the same object and with the same right to use it, as to the Universities of Oxford and Cambridge. The whole idea was founded upon teaching. The apprentice was bound to learn and the master was bound to teach, and a better technical education for the period he could not conceive. The effect of the introduction of machinery was to make the guilds alter their functions altogether, and the relation of master and apprentice was by the same cause changed into the position of capitalist and workman. Machinery brought about a great subdivision of labour, by which the workman was relegated to one small corner of his industry, and did not know the whole mystery of his craft, as he did in the old days. Until recently—until the City and Guilds Institute and other promoters of technical education arose—he had no means of dignifying his labour by understanding the whole field of the industry in which he was engaged. The ignorant workman woke one morning and found that a new machine had been invented which dispensed with his labour. He had learnt to do nothing else, and he was added to the large army of the unemployed, not having had the education to adapt himself to the dislocations of labour which were happening every day. The City and Guilds Institute had been formed to give men the opportunity of acquiring knowledge which would enable them to adapt themselves to the new order of things when such dislocations occurred. He considered that the country owed a great debt of gratitude to the City and Guilds Institute, which had set a noble example to the whole kingdom.

FEMALE PATENTEES.

From a document just issued by the American Commissioners of Patents, it would appear that men do not possess a monopoly of the inventive faculty. The document gives details concerning 2,500 patents, which were granted to women between the years 1790 and 1888. As might be imagined from the sex of the inventors, domestic appliances figure very largely in the list, though feminine inventiveness has not been altogether limited to the domestic field. Among the patents there is one granted in 1864 to a New York lady for an improved war vessel. The same fair inventor appears also to have devoted her attention to locomotive wheels. Another lady, anxious to secure the gratitude of the sterner sex, patented an "improvement in cigars." The assertion that women do not possess the creative faculty to any great extent is somewhat supported by the fact that of the 2,500 inventions not one, it is said, reveals a new principle.

PROTECTION OF INVENTIONS AT THE PARIS EXHIBITION.

An order of Her Majesty in Council has been issued for the protection, under the provisions of the Patents and Trade Marks Acts, of inventions and designs exhibited at the Paris Exhibition to be held next year, whereby the right of the inventor to subsequently apply for a patent shall not be prejudiced, provided that the exhibitor, before exhibiting the invention, gives the Comptroller the prescribed notice of his intention to do so, and also provided that the application for the patent is made within six months from the date of the opening of the exhibition. Similar regulations to the above apply to the protection of designs and trade marks, the application for the registration of which may be deferred to any period not exceeding six months from the date of the opening of the exhibition, provided that the exhibitor before publishing a description of the design gives the prescribed notice to the Comptroller of his intention to apply subsequently for protection.

CONDITION OF THE SKILLED LABOUR MARKET.

The current number of the *Board of Trade Journal* contains a memorandum which has been prepared by Mr. Burnett, the labour correspondent of the Board of Trade, giving some interesting particulars with regard to the present condition of the skilled labour market. Mr. Burnett states that "Although we are now within a few weeks of mid-winter, when many important national industries suffer from a certain amount of re-action on account of seasonal causes, the condition of the skilled labour market, as shown by the returns received from certain trade organisations, continues to manifest a marked improvement. In all, fourteen societies have sent in reports as to the state of employment in their respective industries, and a total of 167,760 members is accounted for. Of this number, 5,231 were unemployed, as against 6,528 for the previous month, a decrease of 1,297. The proportion for last month was 3·5 per cent, whereas now it is 3·1 per cent. For the corresponding month of last year the total of those out of work was 12,223, and the proportion 8·5 per cent. It will thus be seen that not only during the whole of the present year has a great improvement been taking place, but that during the past month the average advance has been more than maintained. Trade disputes have been less frequent, and adjustments of wage rates to the altered conditions of the labour market have been settled by arbitration or mutual arrangement. The building trades have as yet been but little affected by the season, the winter up to now having been remarkably mild and open, a condition from which all the outdoor trades have benefitted. It is in this department of industry only that the number of unemployed is greater than last month, but the increase is so slight as to only increase the per-centage from 3·2 to 3·3. The shipbuilding, ironfounding, engineering, and general iron trades are still augmenting their activity, and are more prosperous than at any time during the last six years. Taking the six chief societies of these branches, it is found that while in December, 1887, the proportion of unemployed was 11·2 per cent, it is now only 3 per cent. A large number of cognate and subsidiary industries depend largely on these trades, as well as a vast amount of unskilled labour, so that the effect of this revival on the labour market is really greater than at first sight appears. A general summary shows that nine societies represent trade as good, three as moderate, and two as bad.

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* *Journal of the Iron and Steel Institute*, 1888, pp. 17, 390.

ILLUSTRATIONS OF THE USE OF THEORY IN THE WORK OF THE ENGINEER.—II.

(Continued from page 639.)

There are two ways in which a technical college and engineers in practice might work together with mutual advantage. Engineers might, without interfering with the apprentice system, give facilities to apprentices to make use of the college so that the workshop training might be supplemented by scientific training. They might also give some small advantages to young men who have had a technical training at that difficult point in their career at which they first enter on practical life. When a young man comes to them, inexperienced it is true, but with a good theoretical knowledge of engineering and quite capable of being commercially useful, they ought not to expect him to place himself on the same level as a boy just leaving school.

Engineers who open their works to engineering apprentices, I am not now speaking of artisan apprentices, have, in some degree, a responsibility for their future career, and they must recognise that they do not, at present, quite adequately fulfil their engagements. The practical education in the workshops is secured, but its necessary complement, the theoretical education, is provided for very inadequately indeed. If in any way we could attain a system in which the theoretical education went on *pari passu* with the practical education, and that without sensible interference with the ordinary apprenticeship, it would be a good thing. Engineers ought, I think, to welcome anything which relieved them from feeling that their apprentices had to trust for one-half their education to chance, and were in that respect unavoidably, while in the workshop, neglected. Now it appears to me that engineers might, without sensible harm to the rules of the workshop, spare engineer apprentices for one day a week to attend a course of instruction in college. It is too much to expect that young men working all day should be able to give up their evenings to hard study, and even if they have energy enough to do some work after shop hours, evening instruction is too scrappy and disjointed to do much good. But instruction carried on systematically through one clear day a week would be much more valuable. I believe even the workshop work would gain from the break in what is necessarily, in its early stages, a very monotonous employment, and engineers would find themselves repaid a hundredfold in securing a supply of more competent assistants to carry on their work.

The questions of trade depression and foreign competition have been mixed up, perhaps not altogether advantageously, with that of technical education. The causes of both are complex, and he who bases an argument for technical education on the assumptions that trade depression is due to foreign competition, and that foreign competition is due to the better technical training of the foreign workman, lays himself open to plausible, if not powerful retorts.

Let us concede, for argument's sake, to the vigorous and, in many respects, well-informed opponents of technical education, who write able letters in the *Engineer*, that "when quality is set against quality, no matter whether it is a machine or a pocket-knife, we are always able to produce the better and cheaper, or as cheap an article, even when cheap wages, long hours, and the ever-boasted better educated workman are said to be against us." Even this vigorous opponent will admit that in thirty years Germany has made an enormous stride towards becoming in mechanical and structural engineering the equal of ourselves. We started earlier, have had the bulk of the engineering work of the world to do, are richer, and happily have been free from the military tax and the interruption of war, which has so seriously impeded industrial development abroad. Yet, at the end of thirty years, the difference between us is greatly diminished. Further technical education may not have enabled the Germans to beat us as yet. Can anyone doubt that German industrial development would have been less rapid if she had not had her technical schools? At any rate, Germans do not seem to think that technical education is a mistake. If the correspondent in the *Engineer* is sure that, at present, we can do any work of engineering as well as the Germans, is he equally sure that years hence, when the pupils of Reuleaux, and Grashof, and Zeuner, and Winkler have reached the higher positions in their profession, we shall be equally a match for them?

Bridge Building.

I cannot speak of the importance of theory in the work of the engineer at this time, without thinking of a very remarkable and interesting paper* by one of the most distinguished of American bridge builders, which at first sight seems to throw doubt on any reliance on theory in practical engineering. One would on this side of the Atlantic have been a little disposed to say that if in any part of the work of the engineer theory had proved a useful guide, it was in the building of iron girder bridges. Almost every improvement of design has been an attempt to conform more closely to conditions imposed by scientific reasoning. And it would be strange if it were not so, for an iron railway bridge is, amongst all structures, that in which the conditions of loading are best known, and the quality of the material used most carefully ascertained. No builder of a bridge of large span would have found his task a possible one without the help theory afforded him.

Mr. Thomson's paper is based on a fact, however, so remarkable that it almost justifies a pessimistic view, if no kind of explanation can be given. He has found that during ten years no less than 250 American iron bridges have completely broken down, sometimes the failure involving serious and fatal accidents. We have no such alarming record in this country, and one would have wished fuller particulars of the failures than Mr. Thomson gives. It appears that in two-fifths of the cases the cause of failure is uncertain; and in one-fourth of the cases the accident was due to derailment of the train, which, striking some principal member of the bridge, caused its failure. Now, Mr. Thomson may be right, that an English riveted bridge would carry a derailed train better than an American bridge. If it is so, we may rejoice, without too much pluming ourselves on our greater foresight, for I don't think we generally take account of stresses due to a derailed locomotive in designing our bridges. At any rate, I think the blame of an accident of that kind must be shared by the permanent way engineer and the engineer responsible for the carriage axles, and not solely attributed to the bridge designer's too great trust in applied mechanics.

But there are specific points in Mr. Thomson's paper to which I should like to refer, as illustrating the relation of theory and practice. It is always from an adverse critic that we learn most, and Mr. Thomson in this paper plays the *role* of adverse critic of theory, although I have no doubt he is far too scientific himself to mean his criticisms to be taken quite as literally as he puts them.

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*American Bridge Failures. *Engineering*, September 14th, 1888.

First of all, Mr. Thomson discusses the prime cause of one-fourth of the accidents—the failure of axles causing derailment. He points out that American axles are nominally loaded to a stress of 15,000lbs. per square inch, or say 6½ tons per square inch. As the stress in an axle is reversed at each revolution, the range of stress to which the outside fibres of the axle are subjected is 13 tons per square inch.

Now, Mr. Thomson next quotes a very interesting fact. He says that a number of axles which had done a record of 95,000 miles, or, as I count, made about 60,000,000 revolutions, were carefully tested at the Watertown Arsenal, and according to laboratory tests the iron was uninjured. On the other hand, merely practical and unscientific tests by a falling weight showed that all axles were so seriously injured after two years' service that they usually broke after two blows.

Mr. Thomson uses this result to throw doubt on the value of laboratory or scientific testing, and asks the question, "what can the laboratory tests teach us regarding the pathology of axles?"

Now, it is really not quite fair that Mr. Thomson should totally ignore the purely laboratory experiments of Wohler, published as long ago as 1871, which showed that no iron could be trusted permanently with a stress of 6½ tons constantly reversed; at any rate, that with a range of stress little greater than this, all bars broke with a limited number of repetitions of loading. Wohler showed exactly how to make the proper laboratary experiment on the endurance of the iron of such axles. Laboratory experiments like Wohler's have been carried on continuously during twenty years, and we are at last getting to understand what Wohler's striking facts meant. It is through extremely refined laboratory researches at Munich that we know something of the cause why different maximum limits of stress must be adopted for different cases in which the range of stress varies. I venture to say that the laboratory results are quite in accordance with practical experience.

I have had some opportunities lately of trying whether in ordinary laboratory tests we could detect any symptom of the fatigue due to long repetition of loading in old material. I am not quite sure that simple tension testing is appropriate to detect fatigue. But it has appeared to me that in old material, with sufficiently refined laboratory measurements, one does notice this fact. The elastic limit of the old material is exceptionally low, and not widely different from the stresses to which the material has been subjected.

So far as I can judge from Mr. Thomson's account, American engineers have too much ignored the scientific knowledge we have of the endurance of railway axles, and I object to this state of things being made into an argument against too much trust in science.

Another of Mr. Thomson's cases is specifically brought forward as an example of the error in relying on mere mechanics. A bridge of 215ft. span fell seven years after erection, causing a serious accident. Mr. Thomson says that the designer sank in the quicksand formula

$$\frac{\text{stress per diagram}}{\text{unit stress}} = \text{section required.}$$

Mr. Thomson gives no clear account of why the bridge fell. He says it was probably due to overloading. If that is the case, surely it was the data given to the designer, not his applied mechanics or his quicksand formula, which led to the catastrophe. Or perhaps it may have been the same neglect of the knowledge we have of the proper limits of stress. Anyway, I should like to see what would happen to bridges, the designer of which paid no attention to the so-called quicksand formula.

I look for more conclusive cases, but I cannot find them. There is one case not described in any careful report, but in a paragraph clipped from a newspaper. This is called a case of a cow, and the newspaper writer suggests that the cow swung its tail against a post when the train was passing over. Really this is like the old apocryphal story of Poncelet's Bridge, which broke down because a shower of rain fell during the testing.

Of course one does not doubt Mr. Thomson's experienced judgment that the question of the best type, the limiting stresses, the proper allowance for loading, in American bridges, require reconsideration. Only one must not take too literally his view, meant probably half humorously, that American bridges fail because they are built too scientifically. Read, however, Mr. Thomson's paper carefully, and I am sure you will profit by it.

(*To be continued.*)

EXCAVATORS AT THE PANAMA CANAL.*

VARIOUS types of excavators have been employed on the Panama Canal works; and illustrations are given of the twelve principal types, together with a brief description of each for the purposes of comparison. Just as the dredger with long shoot effected the completion of the Suez Canal, so the excavator is the chief instrument in excavating the Panama Canal, where the climate necessitates keeping the number of workmen as low as possible, whilst increasing their efficiency tenfold. The first type of excavator, with a chain of buckets accompanied by a transporter of the excavated material, invented by Mr. Couvreux in 1858-59, was tried on the railway of the Ardennes, between Sedan and Thionville, in 1860-63; it was employed on the Suez Canal from 1863 to 1868, on the Danube regulation works at Vienna from 1869 to 1875, on the works of the port of Antwerp from 1874 to 1879, and lastly, with improvements, on the Panama Canal works. Besides the capacity for work of the excavator, depending on the size of the buckets, their rate of motion, and their being filled, an essential point is its stability, for it has to work sideways, and to resist considerable strains. The excavator must accordingly have its centre of gravity low, and it must be of moderate weight; for, if light, it becomes unstable, and if heavy, is difficult to transport. Mr. Couvreux's first excavator, designed for railway work, was made light, so as not to injure the line of way, and could only excavate about 130 cubic yards per hour; whereas now excavators are readily made to excavate 260 cubic yards per hour, and to work at a depth of twenty feet.

The Gobert excavator from Lyons, the French steam excavator from Creil, the modified Jacquelin and Chèvre steam excavator, and the Osgood excavator, referred to and illustrated, have been already described. The Weyher and Richemond excavator, of which four were made for the Panama Canal at Pantin, consists of an iron truck carrying a chain of buckets, and running on four pairs of wheels on the top of the cutting, with two additional wheels running on a rail near the edge of the cutting, to ensure the stability of the machine whilst working. The machinery working the chain of buckets is separate from the machinery for moving the excavator along, so that in case of a failure in the machinery the injury is localised. The beam carrying the buckets is made hollow, of plate iron, so as to be both strong and light; and the machine can both commence and finish a cutting. It can excavate 260 cubic yards per hour; and its steel buckets have a capacity of 7 cubic feet for working in completing a cutting, and a capacity of 9¾ cubic feet for opening a cutting, and some are provided with teeth for breaking up hard ground. The excavator of the Franco-Belgian Society is mounted, like the previous one, on four pairs of wheels to the gauge of the Panama Railway. Two supplementary axles carry a wheel which runs on a third rail, 1⅔ft. beyond the line of way. In this machine there is only a single motor for working the chain of buckets, the change of position, and all the accessory movements, so that the motive force of 70 H.P. is concentrated. There are 16 buckets, with a capacity of 9¾ cubic feet each. In some trials at Pantin, near Paris, this machine excavated from 235 to 344 cubic yards per hour; but in actual work allowance must be made for time lost in altering roads, delays, accidents, and repairs. The amount of work also executed in opening a trench is always greater than in enlarging a cutting.

The Evrard excavator, for enlarging a cutting, is very light and handy, with very little overhang on the side of the beam carrying the buckets. It is on a truck having four pairs of wheels, moving on two rails only, with a wheel base of 14¾ft. This excavator is furnished with two engines, one of 5 to 6 H.P. for moving it along, and the other of 25 H.P. for working the chain of buckets, which carries twelve buckets, with a capacity of 5⅔ cubic feet each.

The excavator of Mr. Henri Satre was designed (1) to possess great stability, by placing the load as far back as possible and lowering the centre of gravity; (2) for the mechanism to be independent of the iron framework; (3) so that the rate of working and translation should be independent, though both motions are imparted by one engine of 55 H.P.; and (4) to possess as much power as possible with a minimum weight, the excavator weighing only 46 tons when empty.

An excavator has been specially designed by Messrs. Demange and Marius Satre for going round sharp curves, which is effected by placing the excavator on three axles, one of which has a power of lateral displacement. The two engines are placed on one side of the chain of buckets, and they are balanced by the boiler on the other side. One of the engines moves the excavator and raises the beam; and the other works the chain of buckets by means of gearing, not by a chain like the excavators previously described.

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* Foreign Abstracts, Proc. Inst. C.E., from Le Génie Civil, vol. xiii., p. 181.

A very good excavator, weighing 58 tons when empty, has been furnished to the Panama Canal Company by Messrs. Boulet and Co., of Paris. It rests on five axles with three wheels each, the third wheel running on a rail placed 1¾ft. from the line of way, on the side next the cutting; and it is worked by two engines, one of 60 H.P. for working the chain of buckets by the intervention of gearing, and the other of 18 H.P. for effecting the other movements. One of these excavators in some trials at Pantin, under favourable conditions, excavated 346 cubic yards per hour.

The Dunbar and Ruston scoop excavator, weighing 32 tons, is formed with a wrought-iron rectangular frame, resting on two pairs of wheels, and is provided with a screw-jack at each of its four corners, so that it can rest firmly upon the sleepers when at work, and be secured from all lateral motion. It has a single engine of 10 H.P. The handle of the scoop can be pushed forwards or backwards, and, by means of chains, can be lowered or raised against the side of the cutting. The scoop has a capacity of 1¼ cubic yard; and the average output of the machine is 785 cubic yards per day of ten hours, which may be increased to 980 cubic yards under very favourable conditions.

LIST OF VESSELS WHOSE ENGINES WERE TRIPLED OR WHICH HAD NEW ENGINES AND BOILERS FITTED IN 1887.

Continued from page 628.

Name of Ship.	Date.	Length.	Breadth.	Depth.	Old Engines.				New Engines or Alteration.					Owners.	Engineers.	Remarks.	
					Cylinders		Stroke.	Pressure.	Cylinders.			Stroke.	Pressure.				
Aberdeen ……….	1871	230	30	17	28½	51	33	55	17	28½	51	33	160	Adam & Co. ……….	Hall, Russell & Co. ..	Engine Tripled.	New Boilers.
Altmore………….	1877	291	35	28	36	66	36	65	22	36	66	36	160	Adam Steamship Co., Limited.	N. E. Marine, Eng. Co., Limited	Ditto	ditto
Atlantica ……….	1868	339	40	33	—	-	—	—	30	51	80	54	—	H. F. Swan, Esq. ……	The Wallsend Shipway Co.	Ditto	ditto
Anchoria ……….	1874	408	40	33	59	107	48	60	30	59	96	48	160	Barrow S.S. Co………	D. & W. Henderson..	Ditto	ditto
Asturiano ……..	1875	275	34	24	35	67	36	60	21½	34	55	36	150	M.M. de Arrotegui ….	D. Rollo & Sons ….	Ditto	ditto
Banguela ……….	1874	302	33	24	40	71	36	—	21	34	56	36	—	British & African Steam Navigation Co.	Fawcett, Preston & Co.	Ditto	ditto
City of Berlin……	1874	488	44	34	72	120	66	—	41	65	101	66	—	Inman & International S.S. Co., Limited	Laird Bros……….	New Engines	ditto
Cosmopolitan ……	1875	274	33	17	33	62	39	70	19½	32	52	39	100	T. Turnbull & Son ….	Blair & Co. ……….	Engines Tripled	ditto
Cremon ………….	1871	302	35	25	—	—	—	—	20	31½	50	42	160	(Foreign owned) ……	Blohm & Voss .. …	New Engines	ditto
Drummond Castle..	1881	365	43	31	51	88	57	75	33	58	88	57	150	Donald Currie & Co….	T. Richardson & Son	Engines Tripled	ditto
Dee ………. …..	1872	300	35	24	35	70	39	—	24	39½	64	39	—	Royal Mail Steam Packet Co.	Earle's Co. ……….	New Engines	ditto
Earnholm……….	1874	170	24	13	27	48	30	70	17	27	48	30	160	Aberdeen, Leith, and Moray Firth Steamship Co., Limited	Hall, Russell & Co. ..	Engines Tripled	ditto
Electric………….	1863	210	27	14	25	49	33	—	19½	31	49	33	—	J. Hay & Sons ……..	A. & J. Inglis…….	….	ditto
Elbe …………..	1870	350	40	33	62	112	48	—	33	53	88	48	150	Royal Mail Steam Packet Co.	Oswald, Mordaunt & Co.	Ditto	ditto
Ennerdale……….	1872	233	30½	17	27	52	33	70	17	27	52	33	150	Milburn Bros. ……..	Baird & Barnsley ….	Ditto	ditto
Europa …………	1881	281	36	24	35	60	39½	—	22	35	60	39½	—	(Foreign owned) ……	(Foreign Engineers)..	Ditto	ditto
Explora ………	1873	300	34	25	$\frac{2}{24}$	$\frac{2}{47}$	39	—	20	33	54	36	160	Charente S.S. Co., Ltd.	Blair & Co. ……….	New Engines	ditto
Galvanic ………	1867	235	27	14½	—	$\frac{2}{39}$	33	—	18½	32½	49	33	—	W. A. Grainger, Esq. ..	Mc.Ilwaine & Lewis..	Engines Tripled	ditto
Grantully Castle ..	1879	360	44	29	51	88	57	75	31	51	82	57	150	Donald Currie & Co. ..	T. Richardson & Son	Ditto	ditto
Gulf of Suez ……	1880	260	34	21	32	60	39	80	19½	32	52	39	160	The Greenock S.S. Co. Limited	Blair & Co……….	Ditto	ditto
Hecla……………	1874	235	31	17	28	54	33	70	17	28	47	33	160	Herskind & Woods ….	Ditto ……….	Ditto	ditto
Jenny Otto ……..	1877	250	33	23	32	59	36	70	20	32	57	36	150	G. Otto, Esq……….	Central Marine Eng. Co.	Ditto	ditto
Kronprinz Friedrich Wilhelm	1871	318	39	31	—	$\frac{2}{38}$	48	—	21½30½	43	61	48	—	Norddeutscher Lloyd ..	Denny & Co. ……..	Engines Quadrupled	ditto
Lara …………..	1868	238	31	15	—	$\frac{2}{48}$	36	—	21	34	55	39	—	Waterford S.S. Co. Ltd	Rollo & Sons ……..	New Engiues	ditto
Magnetic ………	1863	210	27	14	25	49	33	—	18	26	56	36	—	J. Hay & Sons ……..	Walker, Henderson & Co.	Ditto	ditto
Lepanto…………	1877	305	36	26	34	65	42	—	25	39	64½	42	—	T. Wilson & Sons ……	Amos & Smith ……	Engines Tripled	ditto
Malta……………	1862	250	27	19	33	55	33	—	24	38	62	36	—	(Foreign owned) ……	Hawthorn, Leslie & Co.	New Engines	ditto
Mexican ………	1882	378	47	29	50	94	54	90	36	58	94	54	160	Union Steamship Co. ..	T. Richardson & Sons	Engines Tripled	ditto
Myrtle (yacht)……	1869	162	20	12	21½	39	21	50	12 17	24	34	24	180	J. Neil, Esq. ……….	Rankine & Blackmore	New Engines	ditto
Ocean King ……..	1878	350	36	25	46	82	48	70	26	42	68	48	150	W. Ross & Co. ……..	D. Rollo & Sons ….	Engines Tripled	ditto
Pacifique ………	1880	340	40	27	—	—	—	—	26	42	69	54	160	(Foreign owned) ……	Blair & Co……….	Ditto	ditto
Russia ………..	1872	321	37	25	—	$\frac{2}{63}$	45	25	26	41	70	45	150	Russian Sea Nav. and Trading Co.	Hawthorn, Leslie & Co.	New Engines	ditto
Remo …………..	1873	231	30	17	27	53	33	75	17½	29	47	33	150	Neptune S. Nav.Co.Ltd	G. Clark, Esq. ……	Ditto	ditto
Shandon ………	1864	250	28	17	33	66	33	—	21	36	58	36	—	City of Cork Steam Packet Co.	D. Rollo & Sons ….	New Engines	ditto
Suez …………..	1874	323	35	25	36	68	45	70	22 30	43	60	45	160	Nelson, Donkin & Co. ..	Central Marine Eng. Co.	Engines Quadrupled	ditto
Tenasserim ……..	1875	361	37	27	47	82	42	60 24½	37	49	72	42	180	British & Burmese S. Navigation Co.	Denny & Co. ……..	Ditto	ditto
Trojan …………	1880	364	42	28	51	88	60	75	34	54	89	60	160	Union Steamship Co. ..	T. Richardson & Sons	Engines Tripled	ditto
Savona …………	1871	304	33	24	—	—	—	—	21	35	58	39	160	R. M. Sloman & Co…..	N.E. Marine Eng. Co.	New Engines	ditto
Waverley ………	1881	340	40	26	41	78	48	80	$\frac{2}{19}$	41	68	48	160	Williamson, Milligan & Co.	Gourlay Bros. ……	Engines Tripled	ditto
Yeoman…………	1882	285	36	26	35	68	48	85	25	38	63	44	150	W. Lund, Esq. ……..	Wigham, Richardson & Co.	New Engines	ditto
City of Venice ….	1875	379	38	29	50	86	48	70 30	40	52	70	48	145	G. Smith & Sons ……	J. Howden & Co. ….	Engines Quadrupled	ditto

HELICAL WHEELS.—III.

(Continued from page 610.)

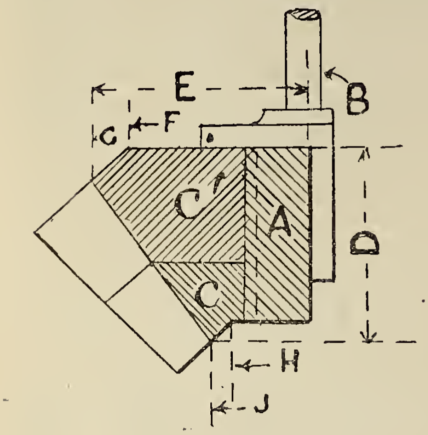


Fig. 7.

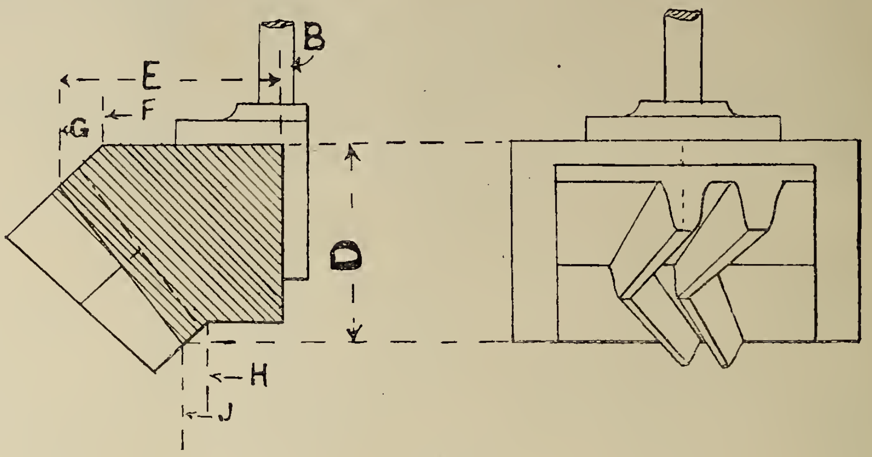


Fig. 8.

The method of striking out a double helical bevel wheel is shown in fig. 6. In this figure, A is the pitch diameter of the wheel, B that of the pinion, C the common apex of the pitch cones; D is the conic frustum which coincides with the depth of wheel A; E the similar frustum which coincides with the depth of B; *a* represents in section the points of the pinion teeth, *b* is the root line, and the faces *c*, *d* are respectively the terminations or faces of the teeth at the larger and smaller ends of the teeth. The method of laying down these lines is so apparent from the figure, being common to all bevel wheels, that I need not pursue the operation in detail.

The forms of the teeth are drawn on planes, projected in the manner shown. Lines are produced continuous with the ends of the teeth until they cut the axial line C F. The radii $c\ c^1$, $d\ d^1$, thus obtained are then the projected radii of the pitch lines on the major and minor diameters respectively. On the line *e f* also in a helical bevel, though not in an ordinary bevel, the projected radius of the pitch line taken on the middle plane of the wheel, is obtained.

These radii are now taken off with trammel, or compass, and struck from a common centre c^1 (the line *e f* being drawn on one side in the figure to avoid crowding of lines). Also the curves representing the root and point lines for each plane are struck concentrically.

The pitch P of the wheel and pinion (which is always taken on the major diameter) is projected to the common centre c^1, and the points of the intersection of these lines on *g* and *h*, give the pitches on the middle and inner planes respectively. In the same way the thickness T of the teeth, and the radii R, R^1, by which the faces and flanks are struck, are projected to the middle and inner planes. These details also are clear from the figure. The angles which the double helical teeth are to make with the middle plane of the wheel are laid down at H, supposed to be on the pitch lines. We have now therefore the data necessary to enable us to construct the tooth block.

We shall suppose the block to be divided, as in the previous illustration of a spur wheel, p. 611, fig. 3. Not that this is invariably necessary, because some machines have provision for drawing unjointed blocks at any angle. And, again, a flat helical bevel, as the wheel A, in fig. 6, will, though unjointed, lift vertically, and one whose bevel is of the opposite extreme will draw horizontally. Much also depends on size and curvature of block, and even when a block may be withdrawn without jointing, it is often much more convenient to divide the teeth, as in spur wheels, for better convenience of ramming; so that if we illustrate jointed blocks, that will cover the entire field.

In fig. 7, as before, A is the backing, B the carrier, and C and C^1 the loose pieces fitting into the backing, and carrying the teeth. The directions in which the several parts are withdrawn are shown by the arrows. In fig. 8 an alternative plan is shown, the entire body of the block being in one, and the thin backing of the teeth fitting into plain grooves.

Without going step by step through the whole process of striking out, which would occupy more space than I have at my disposal, I will simply indicate the lines on which it is necessary to work.

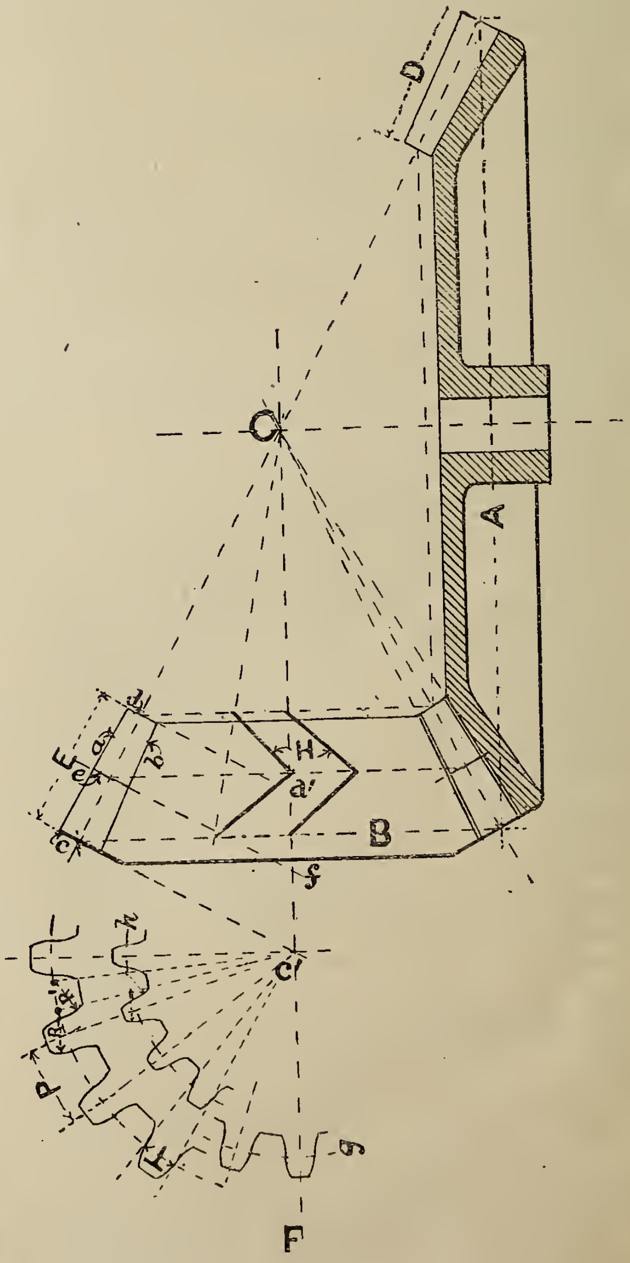


Fig. 6.

First, a gauged cubical block is planed up, having the necessary slides. The thickness of the block will equal the thickness D in figs. 7 and 8. The gauged width will be E in figs. 7 and 8. The centre line, by which the block is set on the carrier, will be squared across each face of the cube. On that centre line, prolonged—unless the wheel is small—to some suitable extraneous surface on the same plane, the trammel point is set for the striking of the radii F, C, in figs. 7 and 8. Turning the block over, and maintaining its correct distance from the trammel centre, the curves of the radii H, J, on the opposite face, are struck. The radii G, H, it is seen, belong to planes which are at this present stage below the squared faces of the cubical block. But having all the necessary radii for curved lines, and all the gauged lines for thicknesses and shoulderings-down shown, any pattern-maker can see from these how he must work in detail to obtain the ultimate sectional form of the block.

The teeth are shown fitted as distinct pieces in fig. 7, but as cut in one with their backings in fig. 8. In bevel blocks the former is the least troublesome. By a comparison of these teeth with fig. 6, the coincidence of the point and root lines and the faces is seen. The tooth angles are set off, and the tooth profiles are struck on outer and inner and middle planes respectively, being taken directly with dividers from the developed forms on the corresponding planes in fig. 6. On the peripheral curve of the tooth points the helical twist is marked with a bent steel.

Two templets may be cut to the shape of the inter-tooth spaces, midway between the outer faces, and the middle plane, if the teeth are of considerable depth. Between these middle sections and the faces on which the profiles are struck the tooth forms will be regulated by the eye, aided, of course, in working, by the helical lines drawn on the tooth points. I particularly lay stress on the correct formation of the helical curve in the working of these teeth. In wheels of large diameter the twist is scarcely, if at all, apparent, and then the teeth may be planed as though for common bevel wheels, and glued and nailed on diagonally at the angles required. But in the small wheels this practice is inadmissible, because in these there is, or should be, a distinctly marked helical form, which, if not imparted, impairs the efficient working of the gears, being a direct departure from the principle upon which they are founded. J. H.

ALLOYS: THEIR CONSTITUTION AND PROPERTIES.—VII.

(Continued from page 633.)

Twenty-four years ago, the accomplished artist, architect, and antiquary, the late Mr. William Burges, delivered a course of Cantor lectures before the Society of Arts. He stated that he "had been requested by the council to show how the arts have formerly been applied to industry; how they are at present applied; and what may possibly be done to increase their application." Mr. Burges dwelt at some length on bronze, brass, gold, and silver, and his lectures, generally, were considered to be so important, that the present Director for Art at South Kensington made them the text for an address delivered before this society in February, 1887, when he reviewed the progress which has been made during the past thirty years. But you will say the metallurgist cannot speak with authority on themes such as these. I have, however, treated the subject in a manner which will, I believe, enable me to bring before you important truths affecting a wide range of industrial operations, and at the same time to sustain the true function of art by pointing to the direction in which we may have increased pleasure in things that constitute our most ordinary possessions, and which we use in daily life. First permit me to explain that I intend to include under the title of the lectures any facts which are, in my opinion, connected with the colours of metals and alloys, whether natural to them or produced by artifice, as well as a brief examination of the influence which the colours of metals appear to have exerted on the history of science.

I propose to begin at what will appear to be a somewhat remote starting-point. We say that copper is red, gold yellow, and silver white, but it is by no means certain that the early races of the world had any very clear perception of the difference between these several metallic colours. With regard to early Hebrew and Greek civilisation, Mr. Gladstone has expressed his belief that the colour-sense—that is, the power of recognising colour and distinguishing it from mere brightness or darkness—was imperfectly developed, and he considers that "the starting-point is absolute blindness to colour in the primitive man," and he urges that the sense of colour has been gradually developed "until it has now become a familiar and unquestioned part of our inheritance." He adds: "Perhaps one of the most significant relics of the older state of things is to be found in the preference (known to the manufacturing world) of the uncivilised nations for strong and, what is called in the spontaneous poetry of trading phrases, loud colour."

Dr. Magnus holds the view that the colour-sense in man has undergone a great improvement within the last two thousand years, and Professor Haeckel supports this speculation. But it is opposed by Romanes, who has favoured me with some observations on the subject, in view of this lecture; and it seems to me strange, if savage nations are really deficient in the sense of colour, that the use of such colours as they can get in metals and fabrics, blended, for instance, in a war-club or a pipe-stem, should be so thoroughly "understood" and so discriminately employed as we sometimes find them to be. It may further be observed that primitive man may even have derived from his more remote ancestry some power of being influenced by colour, and we are told that the attraction which gorgeous colouring in flowers has for birds and insects, and which colour generally possessed for our nearer ancestors, has been of great importance in the origin of species and in the maintenance of organic life.

No doubt in ancient times there was much confusion between mere brightness and colour, such as is evident in the beautiful sentence in which St. Augustine* says: "For this queen of colours, the light, bathing all which we behold, wherever I am through the day, gliding by me in varied forms, soothes me when engaged on other things and not observing her." If, however, it were proved that the power of distinguishing the colour of metals was not widely diffused among the Egyptians, Hebrews, and Greeks, it is at least certain that there were individuals of these nations to whom, in very early times, the colour of metals was all-important; and although they may have confused different precious stones under generic names, they certainly appreciated their various colours, and knew, moreover, that by fusing sand with the addition of a small quantity of certain minerals they could produce artificial gems of varied tints.

My object in leading you so far back—in discussing what appears to be a very matter-of-fact subject—is to point to the close connection between the early recognition and appreciation of colour in metals or minerals, and the foundation of the science of chemistry.

In early scientific history the seven metals known to the ancients were supposed to be specially connected with the seven principal planets whose names they originally bore, and whose colours were reflected in the metals. Thus gold resembled the sun, silver the moon, while copper borrowed its red tint from the ruddy planet Mars. The belief in the intimate relation between colours and metals, the occult nature of which they shared, was very persistent, and we find a seventeenth-century writer, Sir John Pettus, saying that "painters derive their best and most proper colours from metals, whereof seven are accounted the chief, produced from the seven chief metals, which are influenced by the seven planets." A survival of this feeling is suggested by a modern writer, Leslie, who supposed that "when Newton attempted to reckon up the rays of light decomposed by the prism, and ventured to assign to them the famous number seven, he was apparently influenced by some lurking disposition towards mysticism."

It would be impossible for me to overrate the importance of the colour of metals in relation to scientific history, for the attempt to produce a metal with the colour and properties of gold involved the most intense devotion to arduous research, sustained by feverish hope, attended by self-deception and elaborate fraud, such as hardly any other object of human desire has developed. It led to despair, to madness, and to death; but finally, through all, alchemy prepared the way for the birth of chemistry, and for the true advancement of science.

In early times, as now, gold was an extremely desirable form of portable property, and its colour was perhaps held to be the most distinctive and remarkable fact about it. I may incidentally observe that the dominant idea of colour in connection with the metallic currency survives in the familiar phrase, "I should like to see the colour of his money," which curiously expresses a desire, tempered by doubt as to its fulfilment. On looking back, we find that, at least from the 3rd to the 17th century, the colour of gold haunted the early experimenters, and induced them to make the strangest sacrifices, even of life itself, in the attempt to imitate, and even actually to produce, the precious metal. Let us see what kind of facts were known within the period I have indicated. In barbaric times, hammered pieces of gold, or gold beaten into thin sheets or plates, were used with coloured stones and coral for personal adornment. The next step was to make gold go further by gilding base metals with it, and, in order to do this, the colour was for the moment sacrificed by combining the gold with quicksilver. This was done at least in the time of Vitruvius, B.C. 80, heat being used to drive away, as vapour, the quicksilver which had been united to the gold, leaving a thin film of precious metal on the surface to be gilded. But this was possibly not the first method of gilding, for we now know, from a papyrus of about the third century of our era, that lead was used for this purpose. Gold, when fused with lead, entirely loses its golden colour, and yet, by the application of heat in air, the lead may be made to flow away as a fusible oxide, leaving the precious metal on the metallic object to be gilt, the base metal being as it were transmuted, superficially at least, into gold. The point I want to insist upon is that the metallic colour of the gold vanished during the process as carried on by the craftsman, only to re-appear at the end of the operation; and I am satisfied that it was from such simple technical work as this that the early chemists were led to think that the actual production of gold—the transformation of base metals into gold—was possible. The more observant of them, from Geber, the great Arabian chemist of the 7th century, to our own countryman, Roger Bacon, in the 13th century, saw how minute a quantity of certain substances would destroy the red colour of copper or the yellow colour of gold. A trace of arsenic will cause the red colour of copper to disappear; therefore, the alchemists very generally argued, some small quantity of the right agent, if they could only find it, will turn a base metal to the colour of gold. Look, they said, how small a quantity of quicksilver will change the appearance of metallic tin. Here is a bar of tin two feet long and one inch thick, which it would be most difficult to break, though it will readily bend double. If only I rub a little quicksilver on its surface, a remarkable effect will be produced, for the fluid metal will penetrate the solid one, and in a few seconds the bar will, as you see, break readily, the fractured surface being white, like silver. It was by such facts as this that men were led to believe that the white metal, silver, could be made.

Successive workers at different periods held divergent views as to the efficacy of the transmuting agent. Roger Bacon, in the 13th century, held that one part of the precious substance would suffice to turn a million parts of base metal into gold. Basil Valentine, in the 14th century, would have been content with the transmutation of seventy parts of base metal by one part of the agent; while, coming to the end of the 18th century, Dr. J. Price, F.R.S., of Guildford, only claimed that the substance he possessed would transmute from thirty to sixty parts of base metal.

It is a curious fact that no one seems to have actually prepared the transmuting agent for himself, but to have received it in a mysterious way from a "stranger"; but I must not dwell on this. I will merely point out how persistent was the view as to the singular efficacy of the transmuting agent, and I will content myself with a reference to Robert Boyle, our great countryman, an accurate chemist of the 17th century, who did more than anyone else to refute the errors of alchemy. He nevertheless characteristically records the following experiment, in which, instead of ennobling a base metal, he apparently degraded gold to a base one. He first purified a small quantity of gold, about "two drachms," with great care, and, he states, "I put to it a small quantity of powder communicated to me by a stranger"—it is singular that even he should have received the transmuting agent in the usual way—"and," he adds, "continuing the metal a quarter of an hour on the fire, that the powder might diffuse itself through it . . . the metal when cold appeared to be a lump of dirty colour . . . 'twas brittle, and, being worked with a hammer, it flew into several pieces. From hence," he adds, "it appears that an operation almost as strange as that called 'projection'" (or transmutation) "may safely be admitted, since this experiment shows that gold . . . the least mutable of metals, may in a short time be exceedingly changed . . . by so small a portion of matter that the powder transmuted a thousand times its weight of gold." He elsewhere observes of a similar experiment, "transmutation is nevertheless real for not being gainful, and it is no small matter to remove the bounds which nature seems very industriously to have set to the alteration of bodies." The change in the colour of the gold was remarkable, but Boyle had only produced one of the series of alloys most dreaded by every jeweller—"brittle gold"—for the way in which an alloy of gold and copper is affected by a small quantity of impurity presents one of the most serious difficulties in working gold. It has been known since the 7th century that minute quantities of certain metals change the colour of gold and render it brittle, and it may be well to demonstrate the fact.

Here are two hundred sovereigns; I will melt them, and will add in the form of a tiny shot a minute portion of lead, amounting to only the 2,000th part of the mass, first, however, pouring a little of the gold into a small ingot, which we can bend and flatten, thus proving to you that it is perfectly soft, ductile, and workable. The rest of the mass we will pour into a bar, and now that it is sufficiently cold to handle, you will see that I am able to break it with my fingers, or at least with a light tap of a hammer. The colour of the gold is quite altered, and has become orange-brown, and experiments have shown that the tenacity of the metal—that is, the resistance of the gold to being pulled asunder—has been reduced from 18 tons per square inch to only 5 tons. These essential changes in the property of the metal have been produced by the addition of a minute quantity of lead. I have cited these facts mainly to show that the changes produced in the colour and properties of metals by small variations of composition were such as to lead the alchemists on in their belief that it was possible to change lead or tin into gold, and the hope in which they worked enabled them to gather facts out of which chemical science was gradually constructed. We shall see presently that changes in the colour of metals and alloys produced by the addition of small quantities of foreign matter are of great importance in the application of metals to artistic purposes, but we must first try to examine more closely some of the prominent facts connected with the colour of metals, that is, the effect metals have on light, so as to produce the effect of colour in our eyes. We are apt to think of gold as being essentially and distinctly of golden-yellow; it may, however, possess a wide range of colours without in any way losing the condition of absolute metallic purity, its relations to light depending entirely on the nature of its surface, and especially on whether the metal is in mass, or in a more or less fine state of division. Interesting as gold is to us in mass, it is perhaps still more interesting to us when beaten so fine that a single grain, of the value of 2d., would cover space of 48 square inches, or when it is so finely divided that the dimensions of a single particle may closely approximate to those of the ultimate atom.

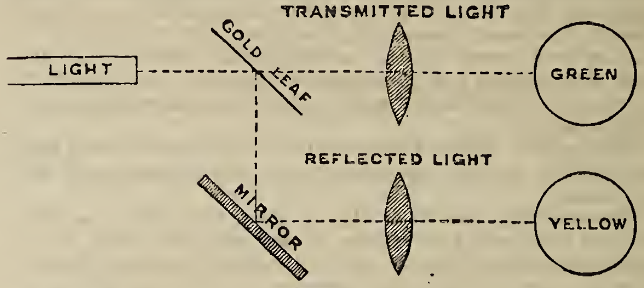


Fig. 1.

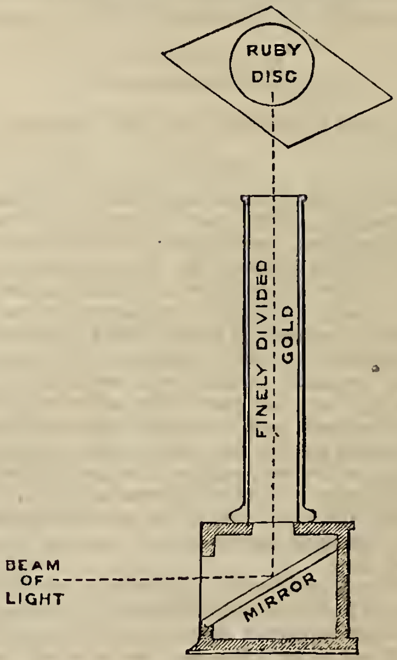


Fig. 2.

This aspect of the question was investigated by Faraday, and the experimental part of the subject as regards gold remains practically as he left it. It is well known that a leaf of gold when seen by transmitted light is either green or blue, according to its thickness. Here is such a leaf of green gold, as seen when light is actually sent through it (fig. 1), so as to project a green disc on the screen. A portion of the light will be reflected from its surface, and this reflected ray may be caught in a mirror and thrown on the screen, so that you have, shown side by side, the green disc of transmitted light, and the golden one of reflected light from the same leaf of gold.

Gold may readily be converted into a soluble chloride which produces a beautiful golden solution. If such a solution contains very little gold, not more than two grains in a gallon, and if certain chemical methods be adopted to precipitate the gold—that is, to throw it out of solution in a solid, though in a very fine state of division—the metal may exhibit a wide range of tint, from ruby to black.

[A few drops of phosphorus dissolved in bisulphide of carbon had been added to about a gallon of a very dilute solution of chloride of gold contained in a tall glass cylinder, as shown in the sketch (fig. 2, p. 650). The beam from an electric light, thrown through the vessel, revealed in the lower part the presence of finely-divided metal, of the natural golden colour, while the more finely-divided gold in suspension imparted a brilliant ruby colour to the liquid, and a glowing ruby disc was projected on a white screen.]

When gold is in the "ruby" state, it is so finely divided that each particle probably approximates to the dimensions of the gold atom.

[The spectrum was then thrown upon the screen, and the audience was invited to compare it with a diagram which, while closely resembling the solar spectrum, really represented the way in which pure metallic gold, prepared by various methods, is capable of behaving in relation to light so as to possess a wide range of colours.]

It would be easy to show that light is similarly affected by other metals, but I have selected gold for the purpose of illustration because it is easy to maintain it in a state of purity, however finely divided it may be. We must therefore modify any views we may have formed as to a metal having exclusively a special colour of its own, because it will be evident that a particular colour is only due to a definite state of arrangement of its particles. The intimate relation between the state of the surface of a metal and its colour is well shown by the beautiful buttons devised by Sir John Barton. He proved that if very fine lines be drawn close together, so that about 2,000 would be ruled in the space of an inch, a beautiful iridescent effect is produced, the tints being quite independent of the metal itself, due to an optical effect of the lines.

(To be continued.)

THE PREVENTION OF SMOKE.

At a meeting of the Manchester and Salford Noxious Vapours Abatement Association, held a few days ago, Mr. Thos. Fletcher, gas engineer, Warrington, gave a lecture on "Flame and Smoke."

In the course of his address, Mr. Fletcher took exception to what he termed the "doubtful service" the agitators for change were doing by pressing the claims of generator or water gas as a fuel for domestic purposes. Another "wild statement" of the anti-smoke agitators was that "carbonic acid is poisonous," a statement often repeated by many who ought to know better. As with smoke and noxious vapours, the agitators had not taken the trouble to separate and distinguish between the action of carbonic acid, which was nil, and that of the objectionable and dangerous germs which accompanied it when exhaled from the lungs of living beings. If anything was to be done worth the doing, the actual facts and difficulties must be faced properly, with a full and practical knowledge of what really can be done and what is necessary.

The production of gas-heating appliances, since the manufacture had been conducted on something like a scientific basis, had become a large and important industry, and from his own knowledge he could safely say that the gas cooking and heating appliances in daily use in this country could be counted by millions, and the demand showed no sign whatever of falling off, but very much to the contrary.

As regarded the abatement of noxious vapours, if they excluded these gas heating appliances, it was a very great question whether any real good had been done. Probably the result had been the other way, as it had led popular attention to black smoke only as being the cause of all our evils; the fact being that pure black smoke, uncontaminated with other products of imperfect combustion, did very little harm, except so far as it interfered with cleanliness. Being visible, it had become connected in the popular mind with other and far greater evils, which were in reality not necessarily connected with it in any way; and a broad and very positive line should be drawn between black smoke, and other products of imperfect combustion, and noxious vapours.

Black smoke was very objectionable, as was any other form of mechanical dirt, and it should therefore be avoided; but they must bear in mind that legislation on this matter was a very difficult thing, and it was quite possible to "jump out of the frying-pan into the fire," by stopping smoke and causing in its place the production of carbon monoxide and other poisonous and offensive compounds of carbon.

First amongst the evils was the sulphur which was contained in all ordinary coal. This was the most destructive and the most unmanageable evil we had to contend with; it combined with the oxygen of the air, forming sulphurous or sulphuric acid, and this all-pervading nuisance could be detected instantly by litmus test papers in the air of any large town, on damp walls, in the gutters, and, in fact, everywhere. There was, he believed, only one remedy, or rather method of reducing the evil, and that was by reducing the total coal consumption in the country, and there was hope in this because a reduction in coal consumption meant a saving in money. It was perfectly useless to talk about the reduction of smoke, or of noxious vapours, unless we could show the offenders very clearly that a profit was to be made by their prevention.

All methods of fuel saving were steps in the right direction, provided, of course, the production of noxious vapours was not increased, as it certainly might be under some circumstances. That coal gas could be burnt without nuisance they all knew, otherwise it would not exist for lighting purposes. That it could be made offensive he had shown them, and, therefore, it would not be unfair to insist that all gas engines should be to a great extent free from the objection which certainly existed with many of them.

With regard to steam boilers and furnaces, there was no doubt whatever that they could be made smokeless, either by using gas coke as a fuel, or by a proper system of firing, such as may be seen on any ordinary locomotive, and there was no doubt, also, that either method could be made profitable; but, on the other hand, there were industries which apparently could not be carried on without the production of smoke and noxious vapours.

Possibly the greatest offenders were ordinary kitchen chimneys. It was only necessary to look over a closely-built town or village on a clear, bright morning, to see where a very large proportion of the nuisance arises, or to visit a hilly district, where they could get above the level of a number of ordinary house chimneys, to appreciate the very unpleasant nature of the products of imperfect combustion which arose, and which always must arise, from slow and imperfect combustion; but the tide in favour of the use of coal gas for ordinary domestic heating and cooking purposes had set in so persistently, and on so large a scale, that what had been already done must have a decided effect on the general cleanliness of the atmosphere.

It might safely be said that coal gas was not by any means at its lowest ultimate price, and that every reduction in price would cause a large increase in the demand for heating purposes and uses other than lighting. In this respect we were decidedly behind some of our own Colonies; for instance, in Melbourne one-third of the total gas made was used during daylight. The value of coal gas for domestic and other purposes required no special pleading; it simply required to be known, and the necessary information was spreading rapidly. As the knowledge of its value spread, so would the demand for all purposes.

COMBINATION SAWING MACHINE.

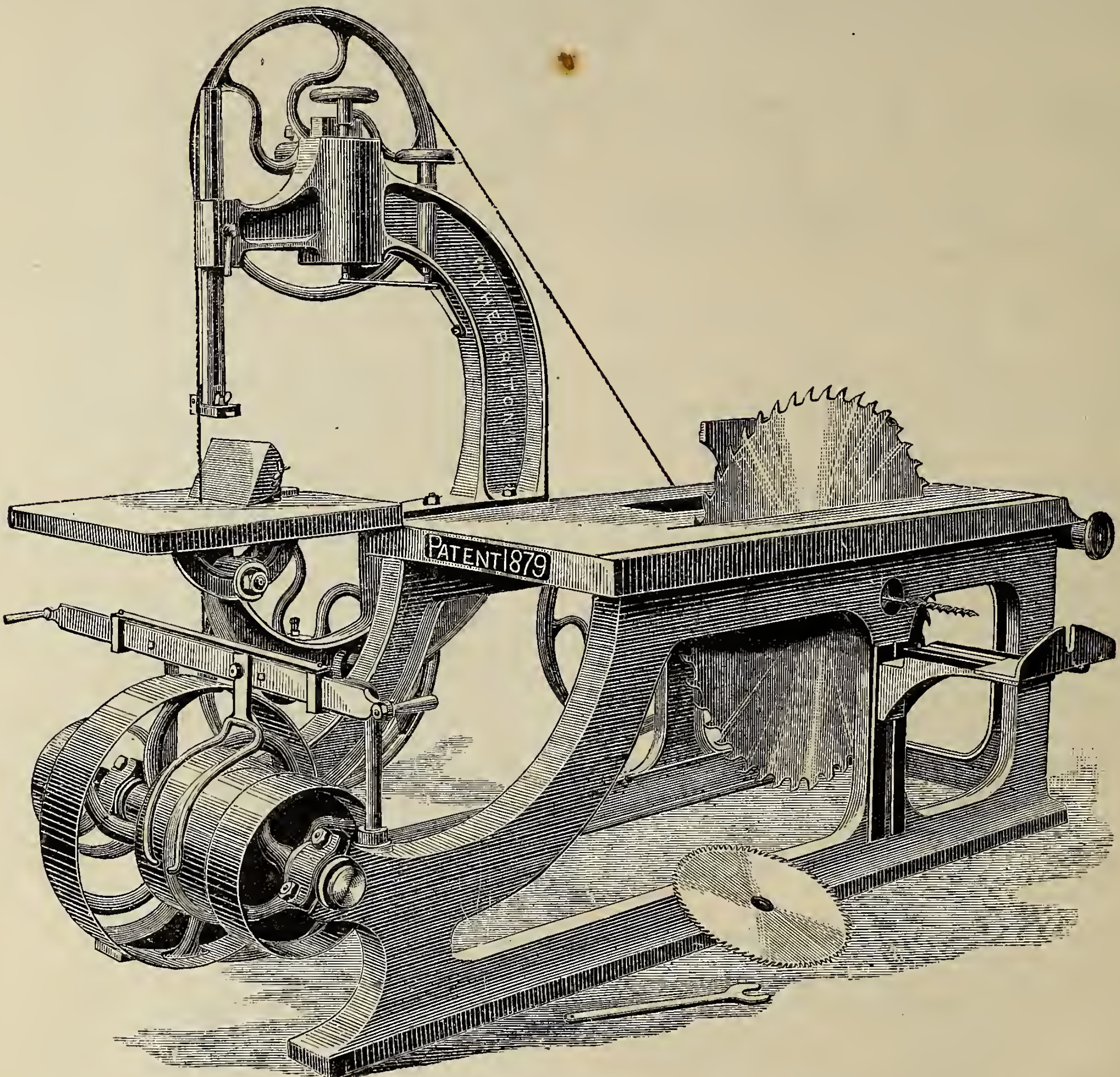
We illustrate on page 652 a very neat form of combined circular and band sawing machine, constructed by Messrs. T. and R. Lees, Hollinwood, near Manchester, which will be found an extremely convenient tool in the pattern room. It possesses the advantages of being simple in construction, while it occupies little space, and at the same time affords ready access to all working parts.

The circular saw bench is fitted with a rising and falling spindle, so that rebating, grooving, or tenon cutting can be readily effected. The saw spindle is of steel, and revolves in strong gun-metal bearings, which are fitted with adjustable lock-nuts, for the purpose of taking up the wear. A strong bevel turnover fence is also furnished, fitted with a fine adjustment screw.

The bandsaw runs over three pulleys, and is fitted with a steel compensating spring, so arranged as to allow for the free expansion and contraction of the saw blade whilst at work. This arrangement is found very effective, and prevents the breakage of the saws, which occasionally constitutes a rather serious nuisance. There is an adjustable saw-guide for various widths of saws, and also an angular fence for tenon-cutting, while the table itself is arranged so that it can be swivelled to any angle when cutting bevels.

COMBINATION BAND AND CIRCULAR SAWING MACHINE.

(For description see page 651.)



THE STEAMSHIP ATRATO.

A MAGNIFICENT new steamship has just been added to the fleet of the Royal Mail Steam Packet Company, London. The vessel, which has been specially designed to meet the Company's Brazil and River Plate service, has been constructed by Messrs. R. Napier and Sons, Glasgow.

The general dimensions of the Atrato are as follows: Length under load-line, 400ft.; breadth, extreme, 50ft.; depth to spar deck, 33ft. 4in.; with a gross tonnage of about 5,300 tons. The vessel is built of steel, classed 100 A1 at Lloyd's, and is designed to attain a high rate of speed, with the greatest possible economy. The builders have supplied a set of triple expansion engines, fitted with all the most modern improvements, steam being supplied by eight single-ended boilers, with a working pressure of 150lb. to the square inch.

The accommodation for the passengers is of the most sumptuous description, and all the details have been carefully considered, with special reference to service in a hot climate. The state-rooms afford accommodation for about 200 first-class passengers, and comprise music-room, ladies' boudoir, dining-saloon, and smoke-room; while there is also comfortable accommodation for 400 third-class passengers. The dining-room is placed on the spar deck, before the machinery, where there is little or no vibration, and is capable of seating about 100 persons. The fittings and decorations of this saloon are of a superb description; the ceiling is divided and panelled in chaste style, and is studded with electric lights, fixed in the centres of the panels.

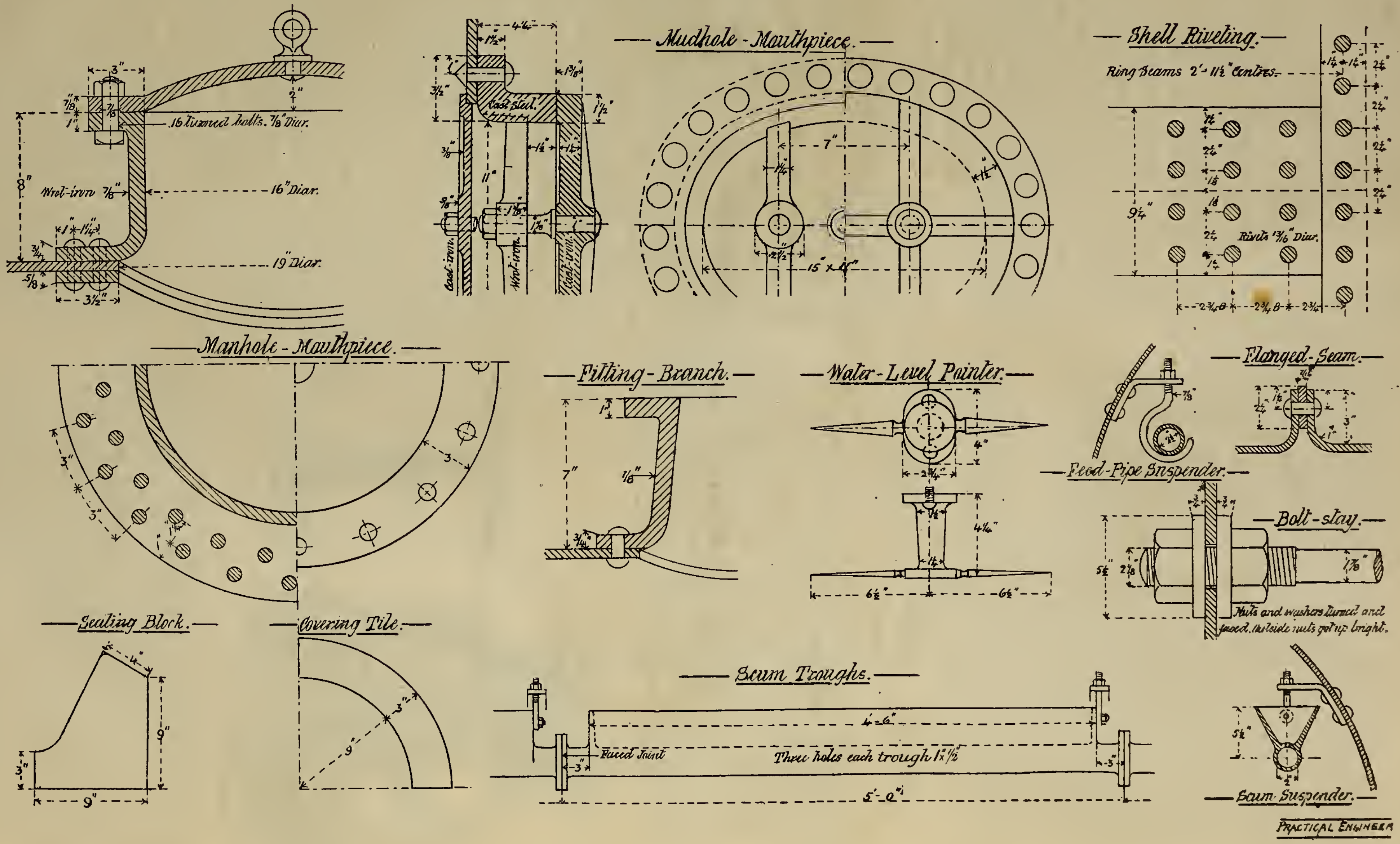
A wide and handsome double staircase leads from the dining-saloon to the promenade deck, which is 200 feet in length, and on which is situated the music room, furnished in an equally exquisite manner, the woodwork being especially rich in carving. The latter, it may be stated incidentally, has, with the exception of the panels in the dining-room, been all executed within the builders' shipyard. The state-rooms are exceptionally large and comfortable, and fitted with every appliance which could add to the convenience of the passengers. A special feature in connection with the state rooms is the wide and well-ventilated passages; while the facilities in the way of baths and lavatories, which are of solid marble, can only be described as sumptuous. The vessel is fitted with the electric light throughout—the appliances, in a word, being equal to that of the most modern hotel on land.

CLOSING OF THE SEA OF AZOV.—Her Majesty's Consul at Taganrog, in a despatch dated November 13th, states that the closing of this sea by ice is the earliest on record since 1860, and that at the time of writing there were eleven British steamers in the roadstead who had not completed cargo, and that there was no prospect of their being able to do so this season.

DETAILS OF LANCASHIRE BOILER.

WORKING PRESSURE 100lb. PER SQUARE INCH.

(For description see page 654.)



DISCOVERY OF A NEW TEXTILE IN RUSSIA.

The French *Revue des Colonies* reports the discovery of a new textile on the shores of the Caspian. This plant, called *kanaff* by the natives, grows in the summer, and attains a height of 10ft., with a diameter varying from two to three centimetres.

By careful cultivation and technical manipulation, M. O. Blakenbourg, a chemist and engineer, who has made a special study of kanaff, has obtained an admirable textile matter; it is soft, elastic, and silky, gives a thread which is very tough, and can be chemically bleached without losing its value. The stuffs manufactured out of kanaff, and then bleached, can be successfully dyed in every shade of colour, and would compete with any of the ordinary furnishing materials now in use. But it is particularly for making sacks, tarpaulin, ropes, &c., that this new textile, from its cheapness, and its extraordinary resisting power, might defy all competition. Its specific weight is much less, but its resistance much greater than those of hemp. Thus, a cord of 8·25mm. diameter, woven with the hand out of three threads of kanaff, requires a weight of 180 kilogrammes to break it. A cord half an inch thick, manufactured at Moscow, did not break until the weight of 625 kilogrammes was reached.

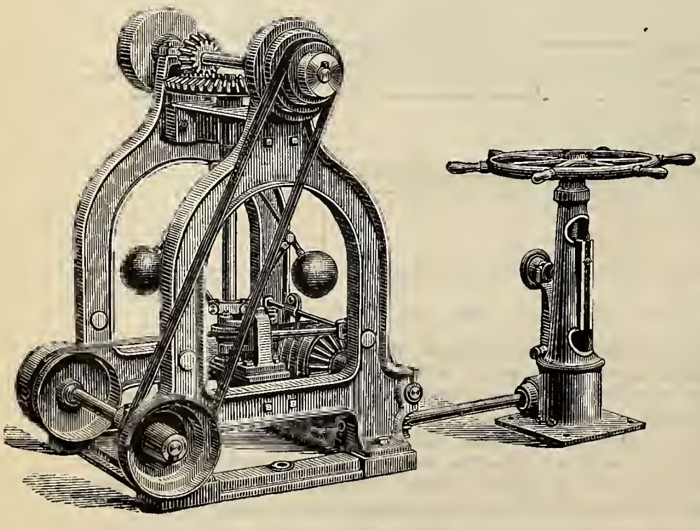
When it is considered that Russia annually consumes more than 150 millions of sacks, a third of which are imported, it may easily be seen that the appearance of this new textile on the Russian market is an event of no slight importance.

IMPROVED TURBINE GOVERNOR.

The accompanying illustration shows a very compact and improved form of governor, which has been specially designed by Mr. W. Gunther, Central Engineering Works, Oldham, for the purpose of regulating the speed of turbines.

The construction and efficiency of this class of water motor has been very much improved within recent years, an improvement, we may remark by the way, to which Mr. Gunther has largely contributed, both by the general excellence of his work and the care and attention he has bestowed in working out the details.

The cheapness and efficiency of turbines, as compared with steam engines, when the requisite water supply and head are available, is much more generally recognised and availed of now than was the case some years ago, though there are many places, however, in this country where there is ample supply of water for power, which is allowed to run to waste, from a popular notion that its utilisation would entail as much expense as the laying down of the requisite steam and boiler plant in the first place, while a steam engine would afford more regular turning. Both these notions, we need hardly explain, are fallacious, and with the aid of the apparatus shown in the accompanying illustration the speed of a turbine may be maintained as regular and uniform as that of an engine in a spinning or weaving mill.



The governor, it will be seen, is entirely self-contained, and is connected with the pillar carrying the hand wheel, which regulates the water supply to the turbine in such a manner that it may be connected at a moment's notice, so that the turbine may be regulated either by hand or by the governor, as desired.

The governor is driven from the pulley on the line shaft, and the speed at which the water supply ports are opened or closed is regulated by a set of cone pulleys. At the further end of the shaft which carries the lower cone a drum is keyed, which drives one of three pulleys on the counter-shaft, which carries the regulating gear. The middle pulley is loose, while the two outer ones are connected to the regulating shaft, which opens or closes the supply ports. When the turbine is running at its proper speed the belt is in the centre of the drum, and running on the loose pulley, but when the speed increases the governor moves the belt on to one of the outer pulleys, and thereby sets in motion the regulating shaft, which closes or opens the water supply ports, until the normal speed is attained, when the belt is moved back again on to the loose pulley. The working of the governor is perfectly silent, while the action is almost instantaneous.

DETAILS OF A LANCASHIRE BOILER.

On page 653 we give a series of working drawings of the details for a Lancashire boiler, for a working pressure of 100lb. The drawings are so carefully worked out and self-explanatory, that a supplementary description is hardly called for, though it may be of convenience to state that the details shown are in accordance with the full specification of a Lancashire boiler which was given in our issues for July 27th and August 10th.

FRICTION OF LOCOMOTIVE SLIDE VALVES.

At the sixth ordinary meeting of the Institute of Civil Engineers of the Session, on Tuesday, the 18th of December, the President (Sir George B. Bruce) being in the chair, a paper was read on "The Friction of Locomotive Slide Valves," by Mr. J. A. F. Aspinall, M.Inst.C.E.

In this communication the author stated that only scanty data existed as to the friction of slide valves, and that the few experiments which had been made were not of a very satisfactory character. Hence he was led to design an apparatus for graphically recording the force required to move slide valves during the whole of their travel. The apparatus consisted of a small hydraulic cylinder and piston, which was made to form part of the valve link. An ordinary steam-engine indicator was screwed on to one end of this cylinder, and an air valve was placed on the other. For pulling, the indicator was on one end of the hydraulic cylinder. For pushing, it was placed on the other end. A second indicator on the valve chest gave a simultaneous diagram of the pressures on the back of the valve. The pressure on one side of the hydraulic piston being atmospheric pressure, that shown by the indicator at the other end was the force required to move the slide valve, less any friction of the apparatus. The author described the experiments made to determine the friction. The results showed that the relation between the pull or the push on the valve and the pressures recorded by the indicator could be expressed by a simple linear equation—$L_1 = 5{\cdot}61 + 1{\cdot}26\,L$, where L_1 was the pressure due to the force required to move the valve, and L the presssure shown by the indicator. The results of experiments with the apparatus on an ordinary brass valve, a brass Allen valve, and a cast-iron valve, were then given, both with the link in full forward gear, and with the link notched up. A small excess of the pushing pressures over the pulling pressures was shown to be due to the steam pressure on the back end of the spindle. Samples of the diagrams and calculations were submitted. As the valve resistance was not uniform throughout the stroke, the causes of variation were discussed. These were the variation of pressure on the back of the valve, the variation of pressure on the face of the valve, the variation of pressure in the exhaust space, and the inertia of the parts in motion. As the most convenient measure of the valve resistance, the author took, not the mean resistance of the valve, but the resistance at mid-stroke, and he compared his results with the few experiments previously made. The author's results made the valve resistance considerably less than it had been supposed from previous experiments. He found the resistance of the valve in motion, with 127lb. to 139lb. pressure on the back, to range from 982lb. to 1,321lb. The valve was 16½in. by 10in. Taking one case, the total load on the back of the valve was 22,110lb.; the relieving pressure on one steam port, 1,800lb.; the relief due to steam in the valve passage, 980lb.; and the relief pressure on the exhaust area, zero. Hence the resultant load was 19,330lb. The force necessary to move the valve was 1,321lb.; the co-efficient of friction was therefore 0·068. Similar calculations for two other valves gave co-efficients of friction of

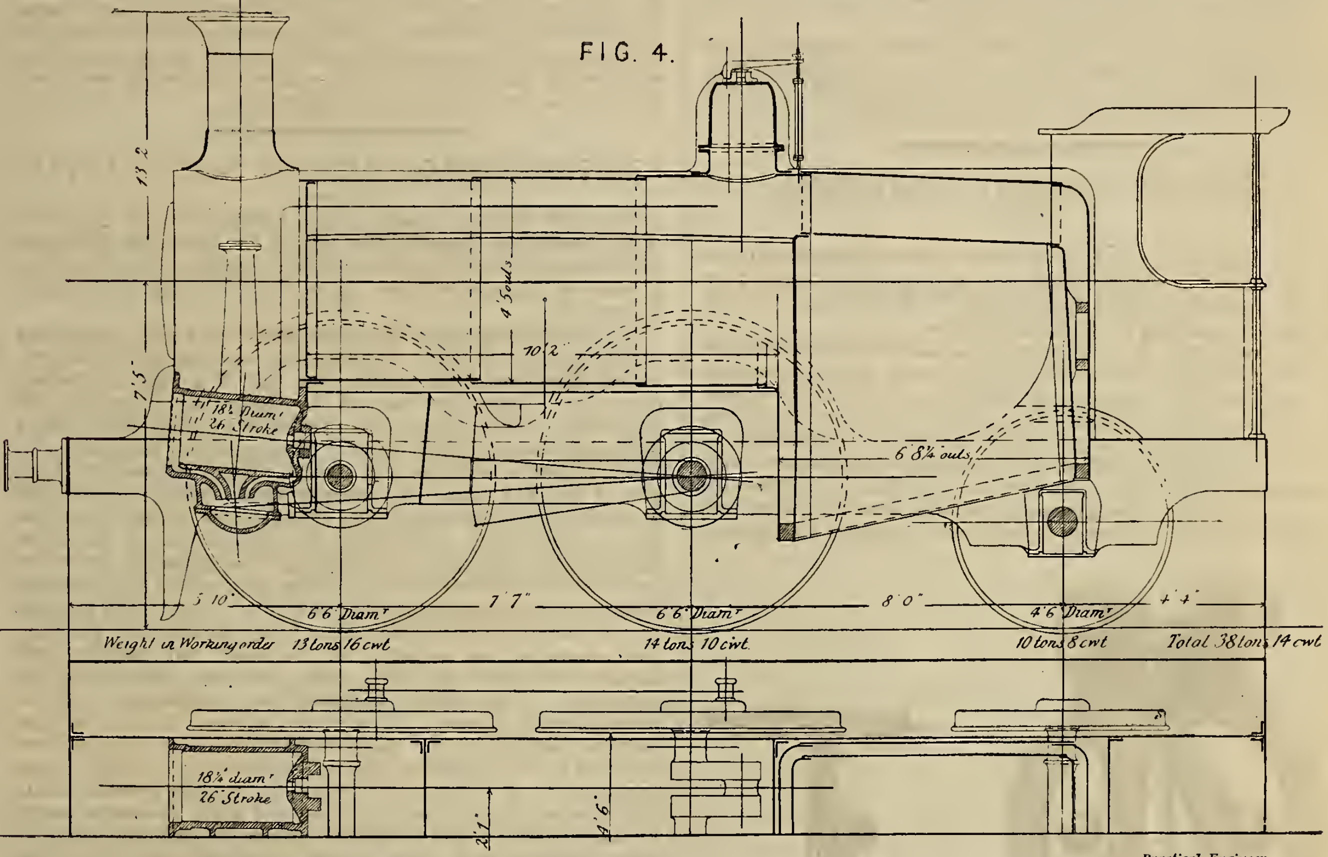
0·054 and 0·051. The lowness of the co-efficient of friction was remarkable, especially as the temperature of the surfaces must be about 350 deg. Fahrenheit. The author calculated the percentage of power lost in slide valve friction at 1·34 to 2·26. Finally, the author discussed the differences of friction due to various modes of lubrication.

SOME TYPES OF THE MODERN LOCOMOTIVE.—III.

(Continued from page 631.)

The three preceding engines illustrate very well what has been done with the single driving wheel, and as I shall describe a four-wheeled coupled engine having the hind wheel coupled when dealing with the compounds, I do not purpose saying anything concerning the Precedent. I have introduced instead Mr. Stroudley's Gladstone type, which has the four leading wheels coupled, this being a departure in express practice. It will be found in fig. 4.

FIG. 4.



Practical Engineer.

Heating Surface: Tubes, 1372·92 sq. ft.; Box, 112·48 sq. ft.; Total, 1,485·40 sq. ft.; Grate Area, 20·65 sq. ft.

The leading particulars of this locomotive are: Inside cylinders 18¼in. diameter by 26in. stroke, coupled wheels 6ft. 6in. diameter, the trailing wheels being 4ft. 6in. diameter. The heating surface is—in the tubes 1,372·92 square feet, and in the box 112·48 square feet, the total being 1,485·4 square feet, and the grate area 20·65 feet. The weight on the rails when the engine is in working order is:—

On the leading wheels	....	13 tons	16 cwt.
„ driving „	....	14 „	10 „
„ trailing „	....	10 „	8 „
Total	....	38tons	14cwt.

The tender has six wheels, 4ft. 6in. diameter; its weight, with 2,250 gallons of water and two tons of coal, being 27½ tons.

This powerful locomotive was designed by Mr. Stroudley to work express on the heavy road from London to Brighton. The inclines are severe, most of the run being up 1 in 264. It takes 25 vehicles, weighing with the engine and tender 350 tons, from London to Brighton, 50 miles, the running time being 70 minutes. Leaving London, 2½ miles have to be surmounted of 1 in 100, then 8 miles of 1 in 264, and altogether about 16 miles of 1 in 264 have to be dealt with in the run.

To take a load of 350 tons on such a road 50 miles in 70 minutes is a fine performance.

The coupling of the leading wheels is a departure in express practice, a large wheel seldom being used to take the road. I believe, however, that no difficulty has been experienced from this, the engine having attained a speed of 67 miles an hour.

One object in coupling the leading wheels was that a long boiler might be used without having recourse to a bogie, Mr. Stroudley being one of the two locomotive superintendents in England who have not adopted it, his contention being that the bogie entails extra expense without corresponding advantages. With the long boiler large tube surface is obtained.

Another reason for coupling the front wheels was, that with this arrangement a larger grate could be got in than with hind coupled wheels, without getting the rigid wheel base longer than convenient, the small trailing wheel lending itself to an extension of the grate. The following particulars are of interest:—

The cylinders are cast together, and as 17½in. is about the largest diameter of cylinder that can be got between the frames on the 4ft. 8½in. gauge, with the valves between them, without unduly contracting the exhaust passages, the valves have been placed underneath; being in this position, they also serve to drain the cylinders, no drain cocks being used. This arrangement has the advantage that when the engine is running without steam the valves fall from their faces, this reducing the wear considerably. This device is not, however, new, as the valves of the locomotive Sphynx, built by Messrs. Sharp, Stewart, and Co. for the M. S. and L. Railway, in 1849, were arranged in a similar manner.

Another point to notice is that the coupling rod crank pin is on the same side of the wheel boss as the inside crank, the usual plan being to place them on opposite sides, which is done to make the coupling rods balance to some extent the inside revolving and reciprocating weights. Mr. Stroudley, however, contends that when the coupling rod crank pin is on the same side as the inside crank, the strain on the crank axle bearings is only that due to the difference between the resistance offered by the coupling rods, and the impelling force of the steam, instead of being the sum of these forces as when placed opposite. And it is said that the saving in the wear of the crank axle brasses, when arranged in this manner, is remarkable.

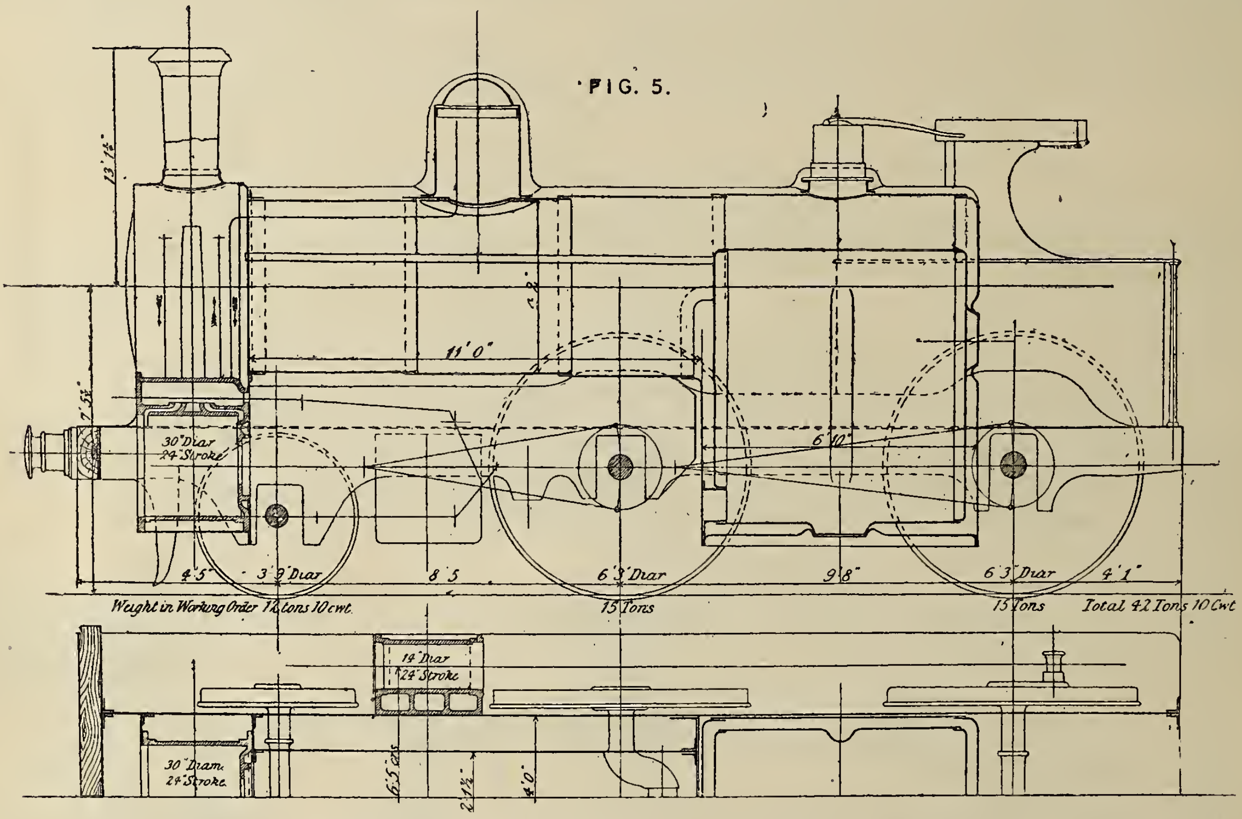
It will be seen by reference to the drawing that the boiler tubes are bent upwards to a camber, instead of being straight, the versed side of the curve being equal to the diameter of the tube, viz., 1½in.; this has been done to prevent the tubes leaking at the tube plates through the expansion and contraction, as it is evident that when bent in this manner the tubes are better able to "give" when required.

The water being fed into the boiler is heated by the exhaust steam passing through an apparatus on the tender. The tubes being closely packed together in the boiler, it is very desirable that the water should be as pure as possible. Now, when water is heated it precipitates lime salts, which, if allowed to enter the boiler, would soon impede the circulation, and in consequence its evaporative efficiency.

It is claimed for this locomotive that only 2·02lb. of fuel are consumed per indicated horse power per hour, though I have some doubts as to the accuracy of the experiments from which this result has been deduced. If they are reliable, this is the most economical locomotive in the world.

The latest departure in locomotive practice has been the introduction of compounding. This, strange to say, has in most instances been applied to the express locomotive, which, even when constructed in the ordinary manner, always works with a high degree of expansion, owing to the difficulty experienced in getting the exhaust steam away at the great piston speed usually maintained.

FIG. 5.



Practical Engineer.

Heating Surface: Tubes, 1,242·4 sq. ft.; Box, 159·1 sq. ft.; Total, 1,401·5 sq. ft.; Grate Area, 20·5 sq. ft.

The goods locomotive, to my mind, offers the better field for improvement by the use of expansive working, as these engines, with a much lower piston speed, and with the great loads that they are required to haul, are mostly cutting off at from half to three-fourths the stroke. Latterly, I see that Mr. Worsdell has compounded his goods engines, which is a step in the right direction.

It is thought by many that the locomotive engine, at anyrate when in its ordinary high-pressure state, is a very wasteful piece of mechanism, and that the power developed is a very small fraction indeed of the theoretical equivalent in the fuel consumed.

M. Marie, of the Paris and Lyons Railway, has made some valuable and interesting experiments on the consumption of fuel and water in the locomotive boiler, which throw some light on this question. He found that the consumption of fuel in passenger engines averaged 3·27lb. per effective horse power per hour, and that it was 2·88lb. per indicated horse power per hour; also that 8·88lb. of water were evaporated per 1lb. of fuel.

M. Regray, of the Great Eastern Railway of France, who made independent experiments, conducted in a very different manner, corroborates M. Marie's results, finding that the averages of goods and passenger engines was 3·01lb. per indicated horse power per hour, and that the minimum was obtained on the express engine, and was 2·48lb. per indicated horse power per hour. M. Marie calculated from his experiments that the efficiency of the boiler alone was 65 per cent, which gives a loss of 35 per cent from a theoretically perfect boiler, and that the efficiency of the engine alone was 54 per cent, the loss being 45 per cent, and the efficiency of the engine and boiler combined was 35 per cent. These results were obtained with a very large heating surface, and 96 times the grate area, and also with very large cylinders. He, as well as M. Regray, found that the consumption was lower in express than in slow running engines. This he attributes to the great piston speeds maintained, and contends that a high piston speed is favourable to economy in fuel, as it diminishes the leakage of steam past the piston, and the condensation during admission.

He also made some exhaustive experiments with a Corliss engine, and a comparison of the results is instructive. In the Corliss engine the boiler efficiency was found to be 64 per cent, and the engine efficiency 53 per cent. In the locomotive, as before stated, boiler efficiency 65 per cent, and engine efficiency 54 per cent. That is to say, that the efficiency of the locomotive compared with a theoretically perfect locomotive is as good as a Corliss condensing engine compared with a theoretically perfect engine working as a Corliss engine. Of course the loss is enormous when compared with the total power stored in the fuel. Yet to prove that in our way we are as economical as the famed Corliss engine is something. Still an economy, however gained, whether by compounding or otherwise, should at once be taken advantage of.

All the experiments that have been made show that there is a gain in the efficiency of the locomotive by compounding over other locomotives that have been doing the same work, but whether there is a gain in the end over the best possible design of the ordinary locomotive for that work, when we take into consideration the increased first cost and the extra expense for maintenance, is open to doubt. Still the compound locomotive is yet in its infancy, and its possibilities are great.

A strange fact in connection with compounding is that locomotives having cylinders without steam jackets have proved more economical than those on which they have been provided. This is no doubt caused through the inefficient manner in which steam jackets are usually drained, causing them to act as condensers; many engineers thinking that if they only surround their cylinders with high-pressure steam, they have done all that is needful. This, however, without automatic draining apparatus, often proves a source of loss instead of gain.

I now purpose giving a short description of the compound locomotives which usually run the trains pitted against each other, and although it is a significant fact that both compounds were taken off during the race and the fastest times obtained by the ordinary engines, still the compounds, being the most novel, will be the most interesting.

So much has been written concerning Mr. Webb's three-cylinder compound locomotive that, although any list of modern express types would be incomplete without some reference to it, still a short description must suffice. An elevation and half plan will be found on plate 3, fig. 5.

The principle of this compound briefly stated is, that two high-pressure cylinders actuating cranks at right angles exhaust into pipes of ample capacity forming a receiver, which feeds a totally independant single cylinder low-pressure engine, fitted with relief valves so that a certain pressure cannot be exceeded in that cylinder.

In the "Dreadnought" class the high and low pressure cylinders are respectively 14in. and 30in. in diameter, the stroke being in both cases 24 inches. The ratio of the two high-pressure cylinders together, to that of the single low-pressure cylinder being 1 to 2·3. The high-pressure cylinders are outside the main frames driving the trailing wheels, and the low-pressure cylinder is inside, and gives motion to the centre wheels, both wheels being 6ft. 3in. diameter.

The leaders are fitted with Mr. Webb's patent radial axle box, having 1¼in. side play either way from the central position, and are 3ft. 9in. diameter. The distance between the high and low pressure driving wheels is 9ft. 8in., this being the rigid wheel base of the engine.

The arrangement of framing is novel, there being the usual inside main frames, and also short supplementary frames inside these, extending from the low-pressure cylinder to the stay in front of the fire-box.

The heating surface in the tubes is 1,242·4 square feet, and in the fire-box 159·1 square feet, making a total of 1,401·5 square feet, with a grate area of 20½ square feet. The working pressure is 175lb. per square inch, which is the highest used in any locomotive boiler that I am aware of.

The weight of this engine in working order is 42½ tons, distributed as follows :—

On the leading wheels	12 tons	10 cwt.
„ Low-pressure driving wheels ...	15 „	0 „
„ High „ „ „ ...	15 „	0 „
Total............	42 „	10 „

This being a most excellent distribution. A distinguishing feature of the boiler is the abolition of the usual bottom ring of the fire-box. The fire-box itself is continued downwards, and fitted with a water bottom below the fire-bars, which serves as an ashpan. This is done to afford a freer circulation for the water than in the ordinary construction, and also allows dirt to be deposited below the level of the fire.

Another point of note is that at the fire-hole the plates of the inner and outer fire-box are brought together and riveted without the intervention of the ordinary fire door ring, which very often gives trouble owing to the unequal expansion of the iron and copper, and the great length of the rivets sometimes employed.

Locomotives designed according to the compound systems, associated with the names of M. Mallett, in France ; Von Borries, in Germany ; and Mr. Worsdell, in England, have one high and one low pressure cylinder. The exhaust steam from the high pressure passing through pipes or other suitable forms of receiver into the low-pressure cylinder, in which it is further expanded. The difference in the systems being in the valves used, when necessary for starting, as when the high pressure crank stops on its dead centre, or where the engine in its normal or compound state, is not sufficiently powerful to make the start. In these cases high pressure steam suitably and automatically reduced (to equalise the loads on the pistons) is admitted into the low-pressure cylinder, and is immediately, and also automatically cut off, when the engine has made a few strokes.

(*To be continued.*)

MINERAL WEALTH OF BRAZIL.

Since the diamond fields of Brazil began to be worked it is said there have been exported from the Empire about 2,500 kilogrammes of diamonds, representing a value of 500 million francs. It is in the province of Minas-Geraes that most of the diamonds have been found ; but they have also been discovered in the valley of Jequitinhonha, at Bahia, at Goyaz, and in other localities, in alluvial lands, either by the banks of streams or incrusted in the rock. Other precious stones exist in Brazil : the topaz, the emerald, the beryl, the amethyst, garnets, jasper, cornelians, chalcedonies, and other gems.

Oxides of iron are very frequent. There are whole mountains which may be described as made of iron. The province of St. Paul is the richest in iron ore. Although the smelting of iron has not been yet developed to any great extent, no less than 680,000 kilogrammes have already been produced at Ipanema. Gold is worked in the province of Minae-Geraes. Other gold is frequently accompanied by palladium and platina. Silver, lead, antimony, and alluminium are abundant.

The calcareous rocks represent one of the least exhaustible sources of wealth to be met with in the Empire. Brazil produces white, grey, green, and rose-coloured marbles, gypsum, and, in the provinces of Ceara and Matto-Grosso, alabaster. In the provinces of Rio Grande-do-Sul and of St. Catherine there are vast coal mines. One of the Rio Grande mines produces two million kilogrammes of coal per month. Turf is found everywhere.

CORRESPONDENCE.

We do not hold ourselves responsible for the opinions of our Correspondents.

CORROSION AND GALVANIC ACTION IN BOILERS.

To the Editor of " The Practical Engineer."

Sir,—We have brass mud plugs in the firebox castings of our locomotive boilers, the threads of which we find waste away and are destroyed very rapidly, either through corrosion, galvanic or voltaic action, or some other mysterious cause. A neighbour of mine informs me, that by drilling a hole in the centre of their mud plugs, which formerly suffered in a similar manner, and filling them up with zinc, or, in other words, putting in a zinc core, the wasting of the threads in their case has been completely arrested.

As from previous correspondence which I have noticed in the columns of *The Practical Engineer*, you have evidently a number of readers who have had good practical experience, which they are both able and willing to give the benefit of to others, I shall be pleased to know whether any of your correspondents cau inform me if the above mode of preventing, or rather, I should say, diverting galvanic action, rests upon any scientific basis, and if it is likely that the cessation of the corrosive wasting at the point of contact with the brass threads would be likely to be affected by drilling out the centre of the brass plugs and inserting a core of zinc, as suggested.—Yours, &c.,

Ironworks Engineer.

DIAMETER OF STEAM AND EXHAUST PIPES.

To the Editor of " The Practical Engineer."

Sir,—Your diagram of Diameters of Steam and Exhaust Pipes is undoubtedly extremely useful, as your correspondent, Mr. Crooke, states in his letter in your issue of December 14th, and I for one should be very glad to see this subject thoroughly thrashed out, but must say the result which he asserts he gets from his 30in. engine is very surprising, viz., only 1½lb. back pressure exhausting at a velocity of 8,000 feet per minute, and can only suggest that as he has taken an approximate valve for the area of his piston, probably he only approximately took the speed of his engine when indicating. I find the speeds allowed for by your diagram are very nearly the same as those given by Seaton in his " Manual of Marine Engineering." Then, again, perhaps if Mr. Crooke was to enlarge his exhaust port, so that the speed of exhaust did not exceed ·6000 feet per minute, he might further reduce his back pressure to only 1lb., which would add about 13 horse-power to his engine.

The diameter he gives for the steam pipe of the 42in. mill engine, assuming the velocity at 10,000 feet per minute, viz., 21in., is evidently a misprint, and should be 11½in.—Yours truly, Exhaust.

P.S.—I find on looking up Proc. I.C.E., vol. xciii., page 187, that Mr. Willins, in his recent trials of a non-condensing steam engine, in one of his sheets of calculations at the end of the paper, had only ·77lb. back pressure, but in that case the velocity of exhaust was very low.

WATER PURIFIERS.

To the Editor of "The Practical Engineer."

Sir,—I have read with interest your article on "Seale's Water Purifier," in your paper of the 30th November. This purifier appears to be an adaptation of the economiser to the inside of the boiler.

When sulphates and carbonates of lime are precipitated by boiling, however, they generally form a hard scale, whether it is in a boiler, economiser, or an open vessel where the water would not be under pressure. What prevents these lime salts attaching themselves to the inside of this particular arrangement of pipes? when we all know how difficult it is to keep pipes free from scale, even Galloway tubes. Surely there is a great chance of the quick precipitating carbonates to fur up the 2in. pipe in the course of a few weeks or months.

Your readers would, I venture to think, be interested to see some results given of what this new purifier is doing. There is only one instance mentioned, and that only a three weeks' trial with river water, which would be more likely to give better results than the clear hard water, for instance from the chalk or red sandstone. At the end of the three weeks' trial it is stated that the boiler was *comparatively* clean. From what river was this water taken for the trial? The analysis showed the 70 grains per gallon was more than half sulphates of lime and magnesia in solution.

I may mention that I know for a fact that the Porter-Clark processes do remove the sulphate as well as the carbonate of lime from water, soda in one or other of its many forms being more generally employed for the former.—Apologising for so long a letter, though the subject is important to many of us, I remain, yours truly,

December 11th, 1888. A Subscriber.

[Our correspondent appears to overlook the fact that the velocity and temperature of the water in the 2in. pipe would largely militate against the precipitation of the lime salts in the manner he suggests. The figures with regard to the amount of impurities present in the water are quite correct, and we fail to see what public advantage would be gained by giving details as to names.—Ed.]

TECHNICAL EDUCATION.

To the Editor of "The Practical Engineer."

Sir,—Some of your readers will probably think that quite sufficient has been written and said on this subject, which the writer partly admits; but possibly the following brief outline of a career from life may be useful in showing that where the want of technical education is adequately realised the opportunity for acquiring it soon presents itself, and the old adage, "Where there's a will, there's a way," is specially true; and the following sketch is given in the hope it may induce some of the younger readers of your useful journal to "Go and do likewise."

Twenty-five years ago, a youth of 15 entered an engineering concern as an ordinary working apprentice to learn the art of turning; the education he had received at school was less than is now taught in our board schools, and consisted of elementary arithmetic, grammar, writing, reading, spelling, dictation, and geography. The work our stripling was first given to do was very laborious, and the days were long, the nine hours' movement not then having been introduced. In a few months' time he was put to work a small lathe where gland studs and bolts were turned and chased by hand, an art in which he soon excelled, but one now seldom practised. His next step was to a larger lathe where a totally different class of work was done, piece-work, &c. After about a year he had the pleasure of being put to work a new screw-cutting lathe, where the work gradually improved, and where he remained for three years. At the end of this time his attention was drawn to some well-finished drawings that came under his notice, and he there and then determined to aspire to higher things, and not settle down to work a lathe to the end of his days. With this object in view, he commenced to make little drawings after work hours at his lodgings, and devoted two or three evenings a week to other subjects, such as algebra, &c., not taught at school, a step which made him feel his ignorance intensely. This evening work was pursued amid the most trying and adverse circumstances, the one room at his lodgings serving as kitchen, parlour, and study, all in one. There were no evening classes of any kind; the only school was this noisy home, and the only teacher was self. At the expiration of four years in the workshop, a vacancy occurred for a tracer in the drawing office, and the subject of this sketch was selected to fill this opening. Several years were spent in the drawing office, while the evening studies were continued.

After working as journeyman draughtsman for a year or so, another appointment was secured on small works, where good experience in designing was gained, and from that time to the present one situation after another has followed in not too quick succession, with, in every case, an improvement in position, until eventually the post of works manager was attained. Many particulars of honours gained *en route* could be given, but fear of trespassing too much on your space compels me to curtail the account.

In conclusion, it is more than likely, but for this application during the apprenticeship, the subject of this sketch would have been working as a turner at the present time, receiving about 26s. a week, instead of earning about the same amount per day, at work requiring the utmost skill.

We strongly advocate the introduction of evening classes and technical schools for artisans where none exist, but these should be provided by public subscription or other voluntary means, and *not raised at the public expense.* It is a fact that those who have had the fewest advantages have generally made the most progress in technical training, and the majority of those who are surrounded with schools and have evening classes in their midst often neglect to avail themselves of their assistance. Teachers and statesmen may be very anxious about the matter, but the majority of our artisans, I am afraid, think more of pleasure, &c., and do not trouble themselves very much about technical education. But when the desire for such knowledge exists, the way to obtain it is soon found, and it is in the hope that the above sketch from life may serve to instil a desire for improvement in the minds of some of your readers that I venture to crave so much of your space.—I am, yours truly,

Dec. 13, 1888. Self Help.

ENGINEERING FORMULÆ.

To the Editor of "The Practical Engineer."

Sir,—The leisure of most professional men is so limited that they have really no time to wade carefully through a mathematical investigation and check the results arrived at stage by stage. They have, consequently, to content themselves with simply following the general reasoning, and making a note of the final results for future use whenever required. One naturally assumes that those taking upon themselves the responsibility of putting any conclusions they arrived at, by careful investigation or by experiment, into print, will be sufficiently careful to check their calculations, so that no simple mistake in arithmetic or algebraical calculation may appear which would affect the result, if only out of regard for their own reputation. There have, however, latterly appeared in the pages of *The Practical Engineer*, and elsewhere, several instances illustrating the importance of not only noting the final conclusions, but of checking over some of the calculations. No man, however clever or eminent in his profession, can lay claim to infallibility, and it is, consequently, not always a safe thing to implicitly accept important conclusions until the *modus operandi* by which they have been arrived at has been carefully followed.

In *The Practical Engineer* of October 5th last, on page 471, a communication is published from Mr. A. G. Clark, on the "Strength of Furnace Tubes," in which are several mistakes, and although the most important of these was subsequently corrected, the correction may never be seen by many who turn to the communication for future reference. In calculating the ultimate elastic deflection of a flat strip, under the circumstances given, we have the following expressions:—

$$\delta = \frac{l \text{ ft.} \times 12}{44} = \frac{300}{4} = 7\tfrac{1}{2}$$

Now, the expression $\frac{300}{4}$ is evidently a misprint, and should be, obviously, $\frac{300}{44}$, but when this correction is made it is difficult to see how the final result is obtained, $7\frac{1}{2}$ as $\frac{300}{44} = 6\ 8$in. A much more important matter, however, is the very serious error which is made at the end of the communication, where the expression $\frac{5000}{d^{1\cdot75}}$lb. per sq. inch is given as representing the collapsing pressures for plain iron flue tubes, constructed with $\frac{3}{8}$in. plates.

An example will soon show the absurdity of this expression, for, taking a furnace tube 2ft. 9in. diameter, and say 30ft. long, such as we commonly find in a 7ft. Lancashire boiler, it will be found, on working out the collapsing pressure of such a tube by the above expression, that this would be *under* 11lb. per square inch, whereas anyone with practical experience of boilers will be aware that there are thousands of such tubes in actual everyday use, which have worked safely for years at from 50lb. to 60lb. pressure.

This error was corrected in a subsequent edition (see *Practical Engineer*, October 26), by Mr. Clark himself, and the above expression altered to $\frac{29000}{d^{1\cdot75}}$ the general expression being also altered from $\frac{36000\,t^2}{d^{1\cdot75}}$ to $\frac{200000t^2}{d^{1\cdot75}}$ which makes a very serious difference, but still, I believe, gives much too low a result for ordinary practice. Many other instances could be adduced showing the importance to practical engineers of carefully following any investigations, and thoroughly testing engineering formulæ before carrying out any important work based on such as have not been tested; but the above, I trust, will be sufficient to show that in technical and scientific matters it is as necessary to carry out the old injunction—"*Prove* all things; hold fast that which is good"—as it is in other concerns of everyday life.—Yours, &c., Azine.

Artesian Wells and Electric Light.—It is proposed to use the water-power of the new artesian well in Paris for the purpose of electric lighting. The well is one of the deepest in the world, the water rising from it with considerable force. The force is estimated to be sufficient to work machinery for the lighting of the surrounding part of the capital.

QUERIES AND REPLIES.

Pitch Striker for Screws.—Will someone be kind enough to favour me with instructions for making a "pitch striker," or where the tool can be bought? The use of the tool is to obtain, with certainty, a true thread by the ordinary hand chaser.—A Fitter.

Answer.—Have you a large number to chase at one time? If so, there is an arrangement designed by a Mr. F. H. Wenham, which might suit you. It is attached to the back of the lathe, and can be turned back out of the way when done with. It gives a positive motion to the chaser. There is, I believe, no instrument of the kind you ask for.—G. T. Pardoe.

Answer.—Does "A Fitter" refer to a gauge to which the chaser or striker is finished? If so, the following may assist. The Whitworth standard is the most common form of V thread now used, and as tables of the number (n) of threads per inch may be found in most works on engineering data, it is not necessary here to state them, unless he is unable to obtain the desired information. Take a 2½in. diameter as an example, where $n = 4$ and the pitch $(p) = \frac{1}{n} = \frac{1}{4}$in. On a piece of thin metal plate, let him mark two parallel lines, $0{\cdot}96 \times p$ apart, and divide one inch on each line into n divisions, making the divisions on one line midway between the others. By joining the points on the two lines, he will have the face of the threads making an angle of 55 deg., which is the standard used by Whitworth; one-sixth of the total depth is rounded off at the top and bottom of the thread to obviate the sharp edges and so increase the strength; the actual depth of the thread then becomes two-thirds of the total depth, or $0\ 64 \times p$. By carefully shaping the gauge to these lines, and making the chaser to exactly fit the gauge, he will then have the thread cut to the correct form. Each gauge should have the diameters to which it applies stamped on for future reference.—Orion.

Varnish for Papier-Maché Goods.—Would some reader kindly inform me how to make the black varnish that papier-maché goods are coated with? I want it so that it will not peel off the card. How is the glaze put on after the goods are varnished?—J. T. L.

Slide Valve of Hydraulic Engine.—Will some reader kindly inform me which is the best form of slide valve to adopt? The engine makes 20 strokes per minute, and the pressure is 1,000lb. per square inch. I should be glad also to learn what kind of stop valve is generally used for hydraulic cranes.

Engine Piston.—I should be glad if some fellow-reader could give me a word of advice with regard to the following: In one of the engines under my charge the junk ring is about $\frac{3}{16}$in. or $\frac{1}{4}$in. too slack for the cylinder, and the piston rod is bearing heavily on the gland. Would it be any advantage to turn the piston head upside down? as at present it is very hard to keep the asbestos packing which I use for the gland tight.

Electricity and Prevention of Scale in Boilers.—Is electricity of any use in removing scale from steam boilers? We have spare power in our dynamo, and if any subscriber would offer a feasible suggestion, I should be willing to experiment, and give the result for the benefit of your readers. I ought to say that I am entirely ignorant as to whether anything has hitherto been tried in this direction?—E. L. R.

Coalpit Management.—Will some reader be good enough to favour me with the name of the best works on coalpit management, saying by whom published, and what is the price?

Re-cutting and Tempering Taps and Dies.—I should be much obliged if any reader would give me a little information as to the process of softening, re-cutting, and tempering taps and dies.—Boltmaker.

Blacklead Pencil Making Machinery.—Can any reader inform me where to obtain the raw plumbago for making ordinary blacklead pencils, also the mode of manufacturing same, and the name of any makers of pencil machinery?—B. B.

TO CORRESPONDENTS.

Parker.—We endeavour to assist our readers as far as possible, but decidedly object to waste our time or space in answering conundrums.

R.W.—The strength of the double rope will vary somewhat with the diameter of the iron forming the capple. We take it, however, that the end will be comparatively sharp, and therefore do not think it will be wise to assume the strength of the double rope at more than 1½ tons. With regard to your query about the plug and bore holes, if we understand your question aright, the effect of the arrangement you sketch would be nil, at all events the plug C would not be forced into the hole in the floor.

A. C.—We think you would find it quite as cheap, and much more satisfactory, to purchase the non-conducting composition, ready made, from persons who have made the manufacture a specialty. Messrs. F. Leroy and Co., Lower Broughton, Manchester, and Messrs. Sutcliffe Brothers, Atlas Works, Godley, near Manchester, are both experienced makers of such compositions, and we should advise you to communicate with them.

MISCELLANEA.

Mining Output in Belgium.—From an analysis of recent mining returns it appears that Belgium now produces over 18,000,000 tons of coal per annum, but as there are 100,739 persons employed in and about the pits, the average yield per man is less than that in this country. The cost of production is, however, very low—a fraction more than 7½ francs per ton all round.

Joint Stock Companies in Great Britain and Greece.—An agreement has been made between the Governments of Great Britain and Greece by the joint stock companies and other associations, commercial, industrial, and financial, constituted in conformity with the laws in force in either of the contracting States, may exercise in the dominions of the other all their rights, including that of appearing before tribunals for the purpose of bringing an action or of defending themselves, with the sole condition, in exercising such rights, of always conforming themselves to the laws and customs in force in the said dominions.

Colour of Lightning.—An interesting communication to the Royal Meteorological Society states that the colours are reversed in the matter of prevalence in sheet and forked lightning. In the former white prevails, then yellow, blue, and red; whereas in forked lightning blue is more than twice as frequent as any other colour. Yellow is most rare in forked lightning, and red is more frequent than white.

The Turners' Company.—The Court of the Turners' Company have just conferred the honorary freedom and livery of the company upon Mr. David Kirkaldy, M.Inst.C.E., for his contribution towards structural safety in buildings, bridges, roofs, and ships, by means of the testing machine invented and made by him some 20 years since, and still used by him for testing all kinds of materials used in construction.

Traction of Canal Boats.—A new method of drawing craft along canals somewhat after the manner of coal tugs on wagon ways is advocated by Mr. Morris Levi. It is proposed to effect the traction by means of an endless rope moving on a pulley on each bank. A paper has been read on the subject before the Academy of Sciences, showing the advantages of the system, and it is stated that some experiments which have been recently made at the instance of the French Council of Ministers proved highly satisfactory.

Newcastle College of Science.—In a circular which has just been issued by the secretary of the college, an appeal is made for additional financial support. Considerable outlay has recently been incurred in the erection of new buildings, &c., amounting altogether to about £38,000. To place the college in a satisfactory financial position, without extension of its buildings, it is necessary that at least £20,000, in addition to the sum already promised, should be contributed within a few months, though the payment of the contributions might be made to extend over two or three years.

Great Activity in Cheshire Salt Trade.—The Custom House returns of the quantity of salt exported from Cheshire during November show that the salt union have had a remarkably prosperous month, for while they have increased prices by 50 per cent they have shipped to all parts of the world 91,770 tons, against 57,614 tons for the corresponding month last year. Many extensive orders are in hand, and the prospects of the union appear very roseate, as, in addition to increased shipments at enhanced rates, many valuable economies have been effected at the works.

Consumption of Lead in Russia.—The employment of lead in Russia is twice as great at the present time, according to the Russian *Journal de St. Petersbourg* for November 17th, as it was five years ago. In consequence of this, the Government has been obliged, since the commencement of 1888, to enforce the energetic working of the silver-lead mines of the Altaï, of Nertchinskst, of the Kirghiz Steppe, and of the province of Tevek. As the product of several of these mines was found to be greatly reduced, in consequence of their exhaustion, new explorations have been made in the hope of discovering fresh beds of lead ore, and these experiments have met with the most complete success. Quite recently, in the upper basin of the Kouban, and of the affluents of that river, beds of considerable wealth have been discovered. The richest is that of Catherininskoé, and this is to be the first of the new lead mines to be worked.

An Electric Travelling Crane.—The application of electricity to the working of cranes has been increasing of late. Perhaps the first practical use of this agent for lifting purposes was the electric hoist of Dr. J. Hopkinson, exhibited at the Paris Electrical Exhibition of 1881. Since then it has been applied to hotel lifts and cranes, but not to any great extent. Quite recently, however, an electric crane of great power was described by Mr. W. Anderson at the Bath meeting of the British Association; and another large travelling crane, worked entirely by the electric current, has been introduced into the timber-yard of Mr. Herrmann, at Limehouse. This crane has been adopted to avoid the insurance rates required for steam cranes which are obviously dangerous in a wood yard, and has been designed by Messrs. R. E. Crompton and Co., of Chelmsford. Hydraulic power might have been used for the crane, but there was already an electric plant for lighting purposes on the premises, and hence electricity was adopted. The new crane runs on a tramway along the roof of the timber warehouse, and is used to raise the incoming logs of timber from the canal. An electric motor is attached to the frame of the crane, and geared with friction gearing of the Raworth type to a central shaft, which, by means of three levers and a foot-brake, performs the three operations of hoisting, slewing, and propelling the crane. The current is conveyed to the electric motor by two copper tubes, laid along the tramway, and taken off suitable contacts. In other respects the crane is of the ordinary build. The power is derived from an 18-unit Compton dynamo, which also supplies 300 incandescent lamps employed for lighting one of the factories. It gives a current having an electromotive force of 110 volts; and some 30 amperes are used to work the crane. It was specified that the crane should lift 15 cwt. as a maximum load, raise 10 cwt. at a speed of 80ft. per second, and slew at the same speed; but as a matter of fact it can lift 18 cwt., and in other respects the specification values have been improved upon.

The Discoverer of the Microscope.—M. Govi, an Italian savant, has presented a paper to the French Academy of Sciences, in which he claims for Galileo the distinction of having discovered the first microscope, as well as the telescope. He has found a book printed in 1610, according to which Galileo had already directed his tube fitted with lenses to the observation of small near objects. The philosopher himself stated, shortly after this date, that he had been able to observe through a lens the movements of minute animals and their organs of sense. In a letter, written in 1614 to a Signor Tarde, he states that he has with his microscope seen and observed flies as large as sheep, and how their bodies were covered with hairs, and they had sharp claws. The date usually assigned to the discovery of the microscope is 1621, and the invention is attributed to Cornelius Drebbel, a Dutchman; but according to M. Govi the date must be thrown back 11 years, and the credit of the first construction awarded to Galileo.

A New Siberian Railway.—While English traders are seeking to open a fresh channel to commerce in Siberia by the Sea of Kara, the Russians are making preparations to build a railway which will place the rich basin of the Obi and the Trytych in communication with some point of the European coast of the North Sea. The scheme was brought forward by M. Golochvastof, and the government granted him the concession for the construction and the working of this line, which will be of capital importance for the future commerce of Siberia. The Malaca-Obi River, near the town of Obdorsk, is the starting point of the line, which will be carried in the direction of the spurs of the Ural Mountains, cross them in a valley which is only 100ft. above the level of the plain, pass over the river Ussa, and then go, by way of the marshy plain of Bolchesemelsk, towards the North Sea, the terminus being in the Bay of Chainuder, above Cape Belcoff. The line will be rather over 400 versts in length, and the construction of a port in the Bay of Chainuder is estimated at two million roubles in paper. This line is not the final aim of the enterprise, being only a means of action for a commercial company which M. Golovatcheff has recently founded. This railway, according to the terms of the concession, will not be public, but will be for the sole use of the grantee. The principal articles of export from the districts of Southern Siberia will be grain and cattle, while the northern districts will export fish, skins, furs, and timber. It is anticipated that ten million poods (36lb.) of wheat will be sent every year from the provinces of Tomsk and Tobolsk.

Douse's Fire Extincteur.—A new fire extincteur has been devised by Mr. T. R. Douse, of 11, Gresham Street, London. The apparatus consists of a metal cylinder, which is filled with an alkaline mixture, into which dips a glass tube containing acid. In this acid is inserted a weak exploder, connected up with a small battery, the whole measuring about 18in. long by 8in. in diameter. This apparatus is fixed either to the ceiling of a room or factory department, or it is placed between the ceiling and the floor of the room above, being thus out of sight, with the exception of the two discharging nozzles. Upon a fire breaking out, the increased temperature starts the electric arrangement, which explodes the cap and breaks the acid tube. The acid at once mixes with the alkaline solution and generates carbonic acid gas, the contents of the cylinder being forced outwards through the sprinkler nozzles. Besides the fire being extinguished, anything within rangee of the sprinklers is at once rendered non-inflammable by the protective solution with which it becomes saturated. As soon as the sprinklers are started an alarm bell is rung, giving notice of the outbreak of fire. Experiments were recently made in an iron house about 20ft. long by 14ft. wide and 12ft. high, fitted with two apparatus, a number of muslin curtains being hung about inside the building. In twenty-five seconds from the time of lighting the fire the sprinklers were brought into play, and the fire was rapidly extinguished, the muslin curtains remaining unharmed by fire, but they were saturated with the solution, and the walls and ceiling of the building were also wetted with it.

The Tin Mines of Perak.—A correspondent of an Eastern journal gives the following description of the tin mines at Taeping. The tin mines are just outside the town, and cover an area of several square miles, and are worked wholly by Cantonese. They are a series of hollows having the appearance of quarries; enormous numbers of coolies, working like so many ants, convey the sand or rubble to the washers' troughs, which are placed at a sufficient height to allow of the water running freely down an incline. One man takes up the minute portions of tin, having the appearance of points of black lead, and which sink at once to the bottom of the trough; others pick out stones from the gravelly mixture; others again push up the heavier portion of the mud from which the lead is not yet completely separated, so that it may pass through the water again, and nothing be lost. The ore is then washed once more in special washing houses, and is thrown with charcoal into a simple furnace, like a barrel standing on end, and made chiefly of clay; the molten lead oozes down through the charcoal and escapes through a hole in the bottom into a pit hollowed out of the ground, the tin being left. The tin moulds are simply holes pressed into the sandy floor by circular wooden rollers, each consisting of half a section, with broad, wooden lips, which leave indentations similar in shape to the blocks of tin shipped abroad. The tin is left here for several days to cool, when it is hauled out with a long iron rod, and dashed with water. It is curious that the only tin mine in Perak supplied with adequate machinery and worked by Europeans fails to give a profit, while the Chinese with their primitive methods can turn the most unpromising mine to advantage.

Forest Conservancy in Upper Burmah.—One of the early measures adopted for the administration of Upper Burmah was the establishment of a system of forest preservation. According to the first report of the new department the officers have not yet mustered in full strength, the staff in July consisting of 11 conservators in place of 21 allowed by the Secretary of State. Several reserves have been marked out, surveys have been made, the regulations are beginning to be enforced, although in the state of the country it was not desirable to enforce them too promptly or severely, and nurseries have been established in various places, at which foreign trees are being acclimatised. Attempts are now being made to rear 149 different kinds of European fruit trees. Under the Burmese Government a revenue of 14 lakhs of rupees was derived from the forests, but as there was no attempt whatever at conservancy this would doubtless soon have diminished; the British Government, in place of farming the forests at different places for a lump sum, purpose levying an *ad valorem* duty on the wood actually extracted. Several of the late king's leases are, of course, still in existence, and these remain in force until their termination. Even in its first year nearly two lakhs of rupees were cleared by the Forest Department, in spite of the circumstance that the political situation, and especially the presence of dacoity, seriously impeded the work. An instance of the manner in which the disturbances paralysed work is given in the report. From the forests of one district the lessees, an English company, extracted 63,000 trees in 1885, while in the two following years they got only 18,000 and 26,000 trees respectively. Some anxiety is felt on account of the wholesale destruction of the cutch trees. On the whole, the Chief Commissioner says of the first year's working of the department: "It is a record of good work done under difficult circumstances, and shows that already a substantial advance has been made in the organisation of an efficient forest department in Upper Burmah."

SELECTED PATENTS.

APPLICATIONS FOR LETTERS PATENT.

December 11th.

18025 Centrifugal Machines, D. McColley Weston, London.—[Complete Specification.]
18027 Gas Apparatus, W. T. Bate, United States.
18028 Halogen Compounds of Boron, &c., W. T. Gihhs, London.
18031 Non-conductor of Heat and Cold, H. W. Johns, London.—[Complete Specification.]
18033 Blast Pipe, H. Lord, Manchester.
18034 Generating Steam, S. A. Ward, Sheffield.
18036 Gas and Petroleum Engines, Wm. P. O'Neill, Longford, and F. O'Neill, Dublin.
18039 Agitators, N. L. Hilton, Manchester.—[Complete Specification.]
18040 Apparatus for Lifting Water, W. Birch, Manchester.
18047 Rotary Motor, W. Simpson, A. Francis, R. Skirrow, and S. Smart, Manchester.
18050 Motors, T. Dealy, Liverpool.
18051 Moulders' Studs, W. Smith, Glasgow.
18053 Steam Traps, J. G. Tongue, London. (J. M. Mitchell, United States.)
18055 Steam Motor Apparatus, J. Hastie and W. Hastie, Glasgow.
18059 Lock Nuts, W. Chattaway, Birmingham.
18074 Nut Locks, G. H. Griffin, London.—[Complete Specification.]
18076 Railways, E. Parsons, Surrey, and R. Parsons, Middlesex.
18083 Band Saws, D. Fau, London.
18085 Pressure Gauge, A. E. Tavernier and E. Casper, London.
18088 Producing Fragments of Iron, &c., L. Keyling, London.—[Complete Specification.]
18089 Flues or Fire-boxes, &c., D. Joy, London.
18091 Electro-motors, W. Aldred, London.
18095 Steam Chests, J. Ross, London.
18102 Chains. J. Kinder, London.—[Complete Specification.]
18109 Machinery for Hulling Coffee, E. Edwards, London. (J. A. Ceulon. Netherlands.)

December 12th.

18119 Gas Holders, W. Gadd and W. F. Mason, Manchester.
18120 Rolling Barbs, E. F. Cummins and W. Pomfret, Cheshire.
18129 Fire-box, C. Delfs, London.
18138 Furnace, J. Walworth, Bradford.
18139 Locking Screw Nuts, H. Pullar, Glasgow.
18144 Draining Land, J. H. Rimell and T. Clements, Birmingham.
18147 Rotatory Engines, S. Washington, Manchester.
18149 Grinding Mills, E. Tourtin, London.
18152 Valves, G. Spencer, Manchester.—[Complete Specification.]
18153 Pressure of Gas, &c., J. Foxall, Newport.
18159 Type-writers, H. Y. Dickinson, London.
18166 Tools, W. Lorenz, London.
18167 Rolls, W. Lorenz, London.
18169 Governor, G. F. Redfern, Middlesex. (O. H. Castle, United States.) [Complete Specification.]
18170 Marine Signal Lamps, F. A. Pommier, London.—[Complete Specification.]
18171 Keys, J. Roemmele, London.
18172 Motor, H. H. Leigh, Middlesex. (L. Gudman, France.)
18173 Compressed Fuel, W. Hotch and G. W. Hughes, London.
18174 Paper Machinery, G. F. Stickings, London.
18178 Turning Ingots, D. Davy, London.
18180 Safety Swivel, W. Burnell, London.
18186 Shutting off the Passage of Fluids, E. J. Barker, London.

December 13th.

18187 Electric Generators, M. Immisch, London.
18191 Furnace Twyere, J. McCann, Millom.—[Complete Specification.]
18196 Grinding Machinery, D. Ashton, Sheffield.
18199 Rollers, C. Billington and J. Newton, Longport.

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